SCIENTIFIC RESEARCH

McGRAW-HILL'S **NEWS** MAGAZINE FOR SCIENTISTS JANUARY 1967

Sir John Cockcroft of Britain

FACING UP TO SHRINKING BUDGETS 21

ALSO IN THIS ISSUE:

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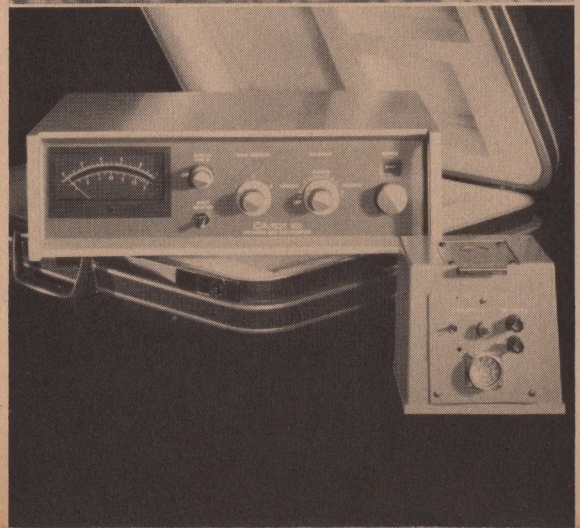

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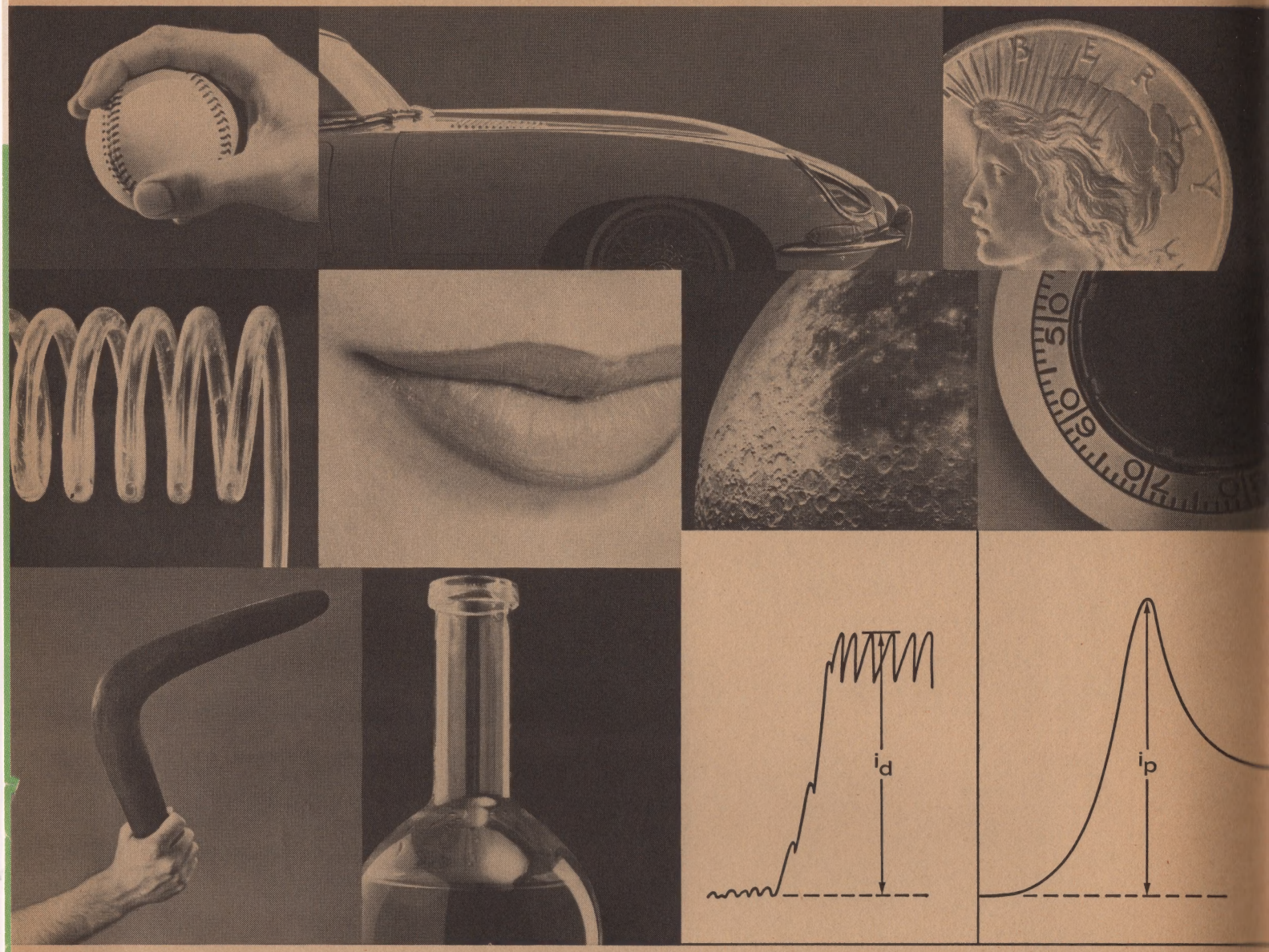

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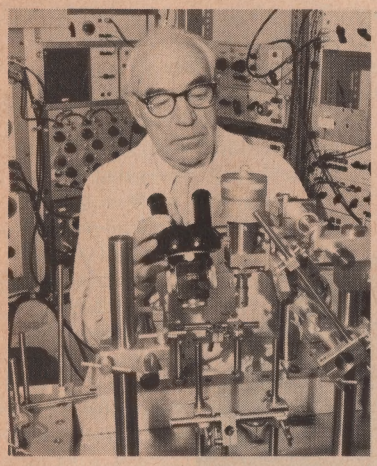
JANUARY 1967
VOLUME 2
NUMBER 1

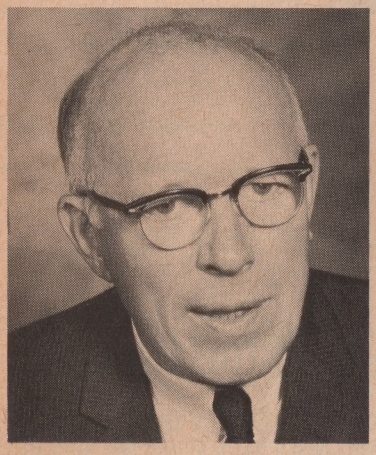
SCIENTIFIC RESEARCH

NEWS



Nobel Laureate Eccles—A new career, in U.S., at age of 63 (p 11)

FEATURES



Biologist Rene Dubos—a dissent on "fashion in research" (p 36)

Cover by Richard Kluga

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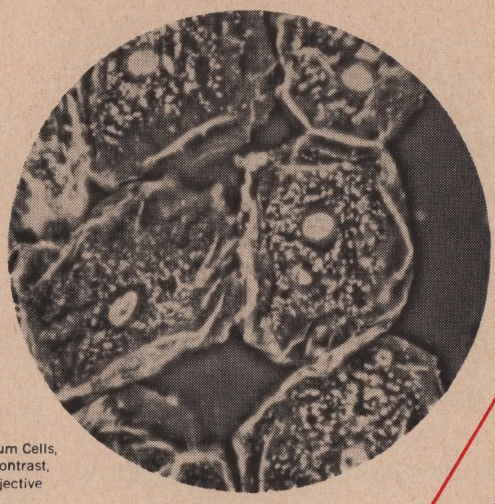

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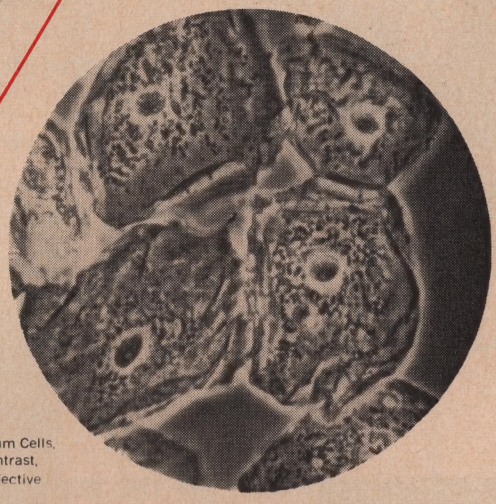

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SCIENTIFIC RESEARCH

JANUARY 1967

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A time to fight

Britain is facing problems in governmental funding of science that are startlingly parallel to those in the U.S., as can be seen from the discussion of Britain's dilemma by Sir John Cockcroft in an article in this issue (*see p 21*). "How should we allocate our limited resources?" he asks, and describes the anguish of those who must make decisions imposed by incompatible pressures as between a 13% annual growth rate in research spending, and a slower-growing budget on which increasing demands are being made by education, health, housing and other sectors of the economy; and as between the needs of "small science" conducted by universities, and "big science" including British participation in international activities such as CERN with its own 13% annual budget growth. Yet the claims of both big and little science to continuing support are well founded.

Sir John proposes cost analysis as one possible guide to decision-making in this agonizing process. In the U.S., the studies that NAS' Committee on Science & Public Policy has made on the subject do not go so far as to recommend possible solutions —they have stopped at analyzing the problem, leaving it up to the government to assign priorities and allocations.

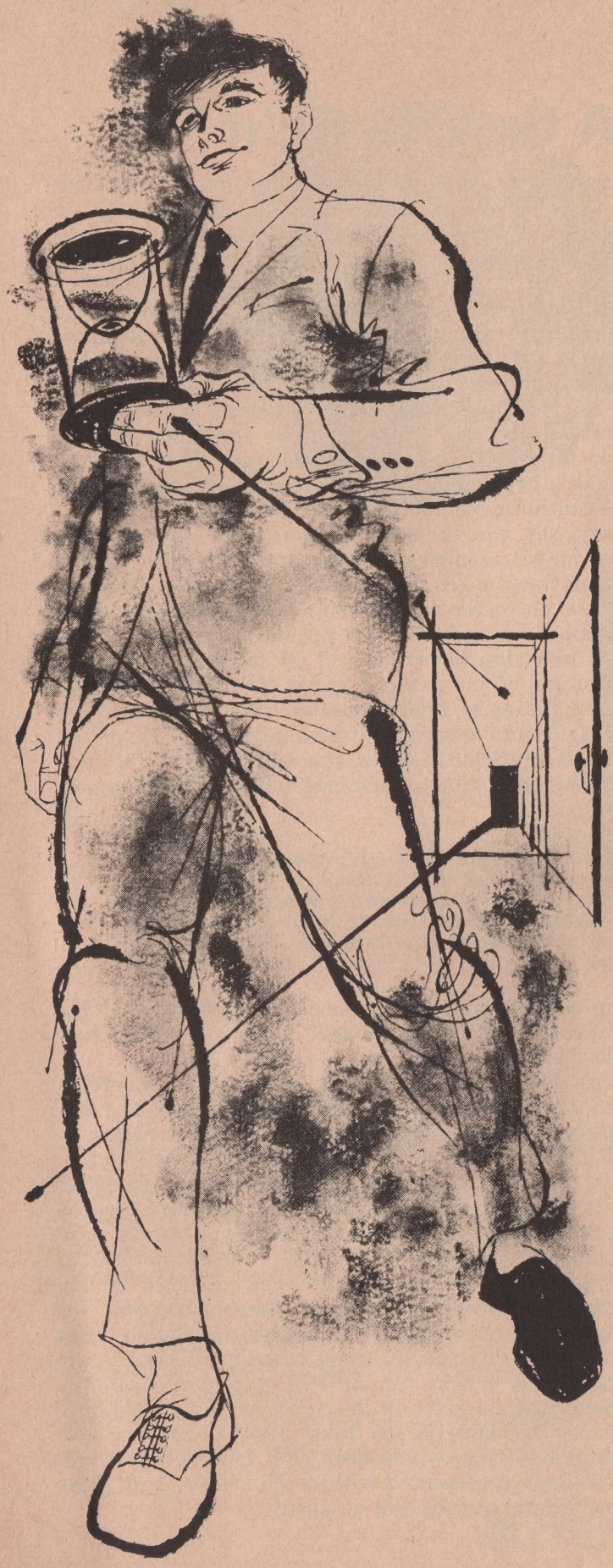
But the magnitude of the problem (total U.S. r-&-d spending, amounting to $23 billion in 1966, increased 264% between 1953 and 1964, with the federal government accounting for 71% of the increase) demands improved methods of dealing with it. The situation was well summarized by a Washington official this summer (S R, May '66, 8):

> The days of spectacular year-to-year increases in the federal science budget are over. And it seems to me that it's the responsibility of the scientific community to assist the President and the President's advisers in making the allocations of federal spending as among the various disciplines—not just ask for more money.

It does seem odd, in view of the amounts involved that the nation's science community plays so small a role in advising how that pie should be sliced.

In addition to the problem of how to slice the pie, there is the problem of trying to keep the whole pie each year, and keeping it growing at an appropriate rate. It must be clear to all, now, that science faces a financial crisis in Washington. The question is: What is the science community doing about it?

We think it is in the national interest that our strong research posture not be permitted to deteriorate in the face of budget pressures. We think the scientific community should not stand mutely by while this deterioration threatens. Science should mobilize to fight the continuing fight for those allocations for research the national interest demands. And science should insist on participating fully in the decisions on how the allocations are to be made. Perhaps it is time for COSPUP—from which many had expected a more aggressive role in science and public policy—to re-examine its decision not to take positions on science-resource allocations. Perhaps it is also time for science to get itself more effectively represented within the precincts of those who decide how federal monies will be spent.



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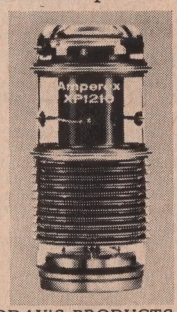

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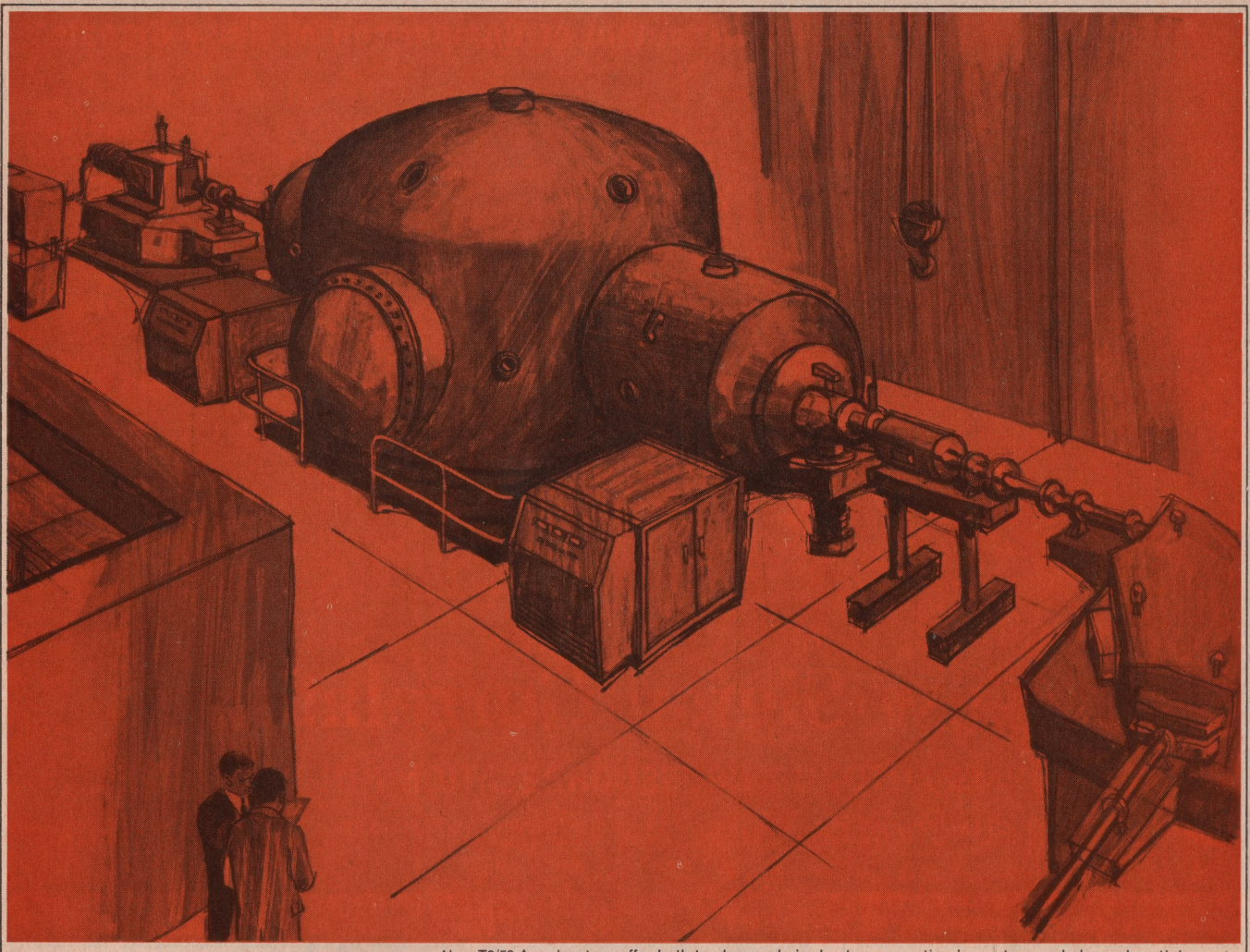

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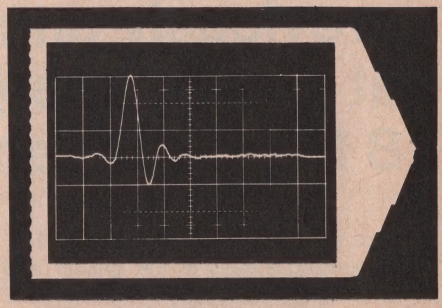

Typical Photograph of Crosscorrelation Function of Input and Output Signals of Complex Passive Network Driven by White Noise.

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Pittsburgh

ANTHROPOLOGISTS CONSIDERING STAND ON INTELLIGENCE WORK

A stand against U.S. government agencies using overseas social sciences research as a front for intelligence activities is being prepared by the American Anthropological Association.

A plan of recommended action has been circulated among members and, at the time of writing, was scheduled to be decided upon by mail ballot by the end of the year. It is understood that the Association wants to set up guidelines for members, urging universities not to undertake contracts or activities in the social sciences which are unrelated to their normal functions of teaching, research and public service.

Members will be urged to avoid clandestine operations, collection of secret data or preparing classified research reports needing security clearance of the university staff taking part. Government agencies will be asked to avoid involving universities and private researchers in intelligence activities, it is believed.

This all stems from a report given at a recent Association meeting in Pittsburgh by Ralph L. Beals, professor of anthropology at the University of California, Los Angeles. Beals and Stephen T. Boggs, then executive secretary of the Association, prepared the report with the aid of a special committee on research problems and ethics.

Just what action the Association will take is not clear. Beals told SCIENTIFIC RESEARCH that when the report was presented the Association tabled a statement of policy because the wording was "ambiguous and might have led some members to interpret it as saying more than was intended." The statement was then set aside for rewriting before sending out to members for mail balloting.

Fredrica de Lagun, Association president, denied that the delay was an attempt to back away from the issue or to "sweep it under the rug." She did not envisage any direct action by the Association after balloting, but said the recommendations would be used as a set of guidelines for members.

Beals caused quite a stir at the meeting when he reported on a year-long study. He revealed that agents of U.S. intelligence departments, especially the Central Intelligence Agency, have posed as anthropologists or said they were doing research in anthropology when in fact they were not qualified or competent to do so.

He told the meeting that anthropologists have been full-time or part-time employees of federal intelligence agencies, including the CIA, directly or through grants from foundations with questionable sources of income, or as private research organization employees.

He reported that one U.S. anthropologist is believed to be a full-time agent of a foreign power.

Beals revealed that some anthropologists, especially the younger ones, have been approached by obscure foundations with research support offers. Later, the scientists found they were expected to provide

Ralph L. Beals: against social sciences research espionage

intelligence information, usually to the CIA. A few anthropologists have been interviewed by embassy officials in the country of their research or by intelligence specialists in the U.S. after returning home.

Beals has advised anthropologists to be cautious in accepting funds from alleged foundations which do not publish the sources of their money. They should be especially concerned with the effect of their sponsorship on the foreign country in which they are working, since some U.S. agencies providing funds are totally unacceptable to many countries. These agencies include the CIA, Defense Department, U.S. Information Service and State Department.

Beals disclosed that some social scientists are accused of being spies, communists or even protestant missionaries. Where the anthropologist-spy is genuinely an agent he is usually preferred in some countries with a long history of espionage, because he can be easily identified and fed with false information, he said.

Beals recalled that after the furore over Operation Camelot, an Army-financed study of social change in Chile which ended with an official protest from that country to Secretary of State Dean Rusk, serious discussions have begun in Congress to promote the welfare of the social sciences. This includes proposed legislation to set up a national social sciences foundation or to expand the mandate and funds of the National Science Foundation.

Beals has asked the Association to question the wisdom of having a separate foundation and to push for increased funds for existing channels of support such as the NSF, the Smithsonian Institution and the National Institute of Mental Health.

He has also sought to get Association support for Congressional bills aimed at establishing an office of social sciences in the Executive Office of the President, and at setting up a Commission on a White House Conference on the Social and Behavioral Sciences.

Brighton, England

THREE-NATION SCIENCE POLICY STUDIES BEGUN IN BRITAIN

By examining the social, economic and military conditions that flowed from different science policies in Britain, the U.S. and West Germany over many years, a team of researchers at Sussex University, Brighton, England, hopes to establish criteria for successful science planning—in any western nation.

The group, led by American science historian Roy MacLeod of Harvard, have started putting together a fully-documented history of U.K. science policy dating back to 1815. From this study, lessons applicable to the present can be drawn. Among the things MacLeod's team want to know is what criteria have been used to justify science spending in Britain.

MacLeod is adopting a "case study" approach, sifting through documents of various selected government agencies that existed to

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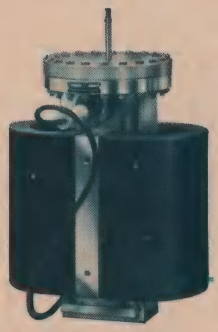

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stimulate science to find out how and why they supported their projects. University archives are also being searched.

MacLeod is a biochemist and a historian of science. His two research assistants include a chemist and a political sociologist. The other skills represented in the Unit as a whole are economics, geophysics and the arts.

A second and parallel study will be started this year in West Germany by Heidelberg's Studiengruppe für Systemforschung. MacLeod will take time off from Sussex University in 1968 to set up the third study (of the U.S.) at the Smithsonian Institution, Washington.

The MacLeod project at Sussex was launched in May by the university's Science Policy Research Unit, headed by Christopher Freeman. The unit was created only a year ago, but has already acquired a reputation for itself as a force to be contended with in the "science of science." Little but organization and preliminary studies have been achieved so far.

Another group within the unit is studying science policy in India and China. The United Nations is supporting its work. There's another ambitious project that Sussex hasn't started yet. Freeman calls it his "data bank project", in which he plans to analyze the environment that leads to scientific discoveries and their successful commercial exploitation.

Chicago

NOBEL LAUREATE ECCLES EMIGRATES TO U.S. AT 63

The U.S. has yet again profited from the brain drain. Nobel laureate Sir John C. Eccles, former president of the Australian Academy of Sciences, has joined the American Medical Association Institute for Biomedical Research in Chicago.

He came to this country to avoid being retired from top-level research and will stay here permanently. Sir John, 63, is modest about the effect of his departure on Australian science. He told SCIENTIFIC RESEARCH: "I don't suppose there will be any problem. There are other excellent people there and my principal colleague is staying behind."

The Australian government would not change its retirement-at-65 rule, but Sir John said he made no effort to have the rule changed. He could have continued research, but at a much lower level, he said. "I did not make any bargains, but simply decided to accept the Chicago position. I told the Australian authorities not to make an effort to hold me, and just told them I was going."

Eccles said he can now continue his work on the mechanisms of nerve impulses and their transmission modes—which won him a Nobel Prize in 1963—at an intensive level. Furthermore, he won't have to retire at any preset time.

Why was Sir John attracted to Chicago? "Good opportunities," he said, which include fully-financed research and elimination of applying for grants, a complete, modern laboratory set up to his own specifications, and a staff of eight colleagues together with the usual lab technicians.

No retirement for Nobel laureate Eccles; emigrates to U.S.

Eccles is already no stranger to the U.S. since he made some 20 trips here before settling down. He said: "I feel I don't belong to any particular country. I have lived 12 years in England and nine years in New Zealand. I will stay in the U.S. for as long as I can go on working."

Research planned by Eccles at his Chicago laboratory includes further investigation of cerebellar performance and neuro-communications, how these "messages" are carried into the cerebellum, and a comparative study of the cerebellum in various types of vertebrates.

AND IN SWEDEN . . .

The Swedish government has made a determined effort to stem the brain drain. It has just made use of a special law to keep a prominent scientist from emigrating to Harvard University. The government has established a special "personal chair" in mathematics at the University of Uppsala for Lennart Carleson, a 38-year-old mathematician who had been offered a U.S. professorship.

Ordinarily, the Swedish parliament must approve establishment of a university chair and the new law enables the government to act quickly. Carleson was named a Stockholm University professor at the age of 26.

Moscow

RUSSIA MOVING TOWARD 1,000-BEV ACCELERATOR

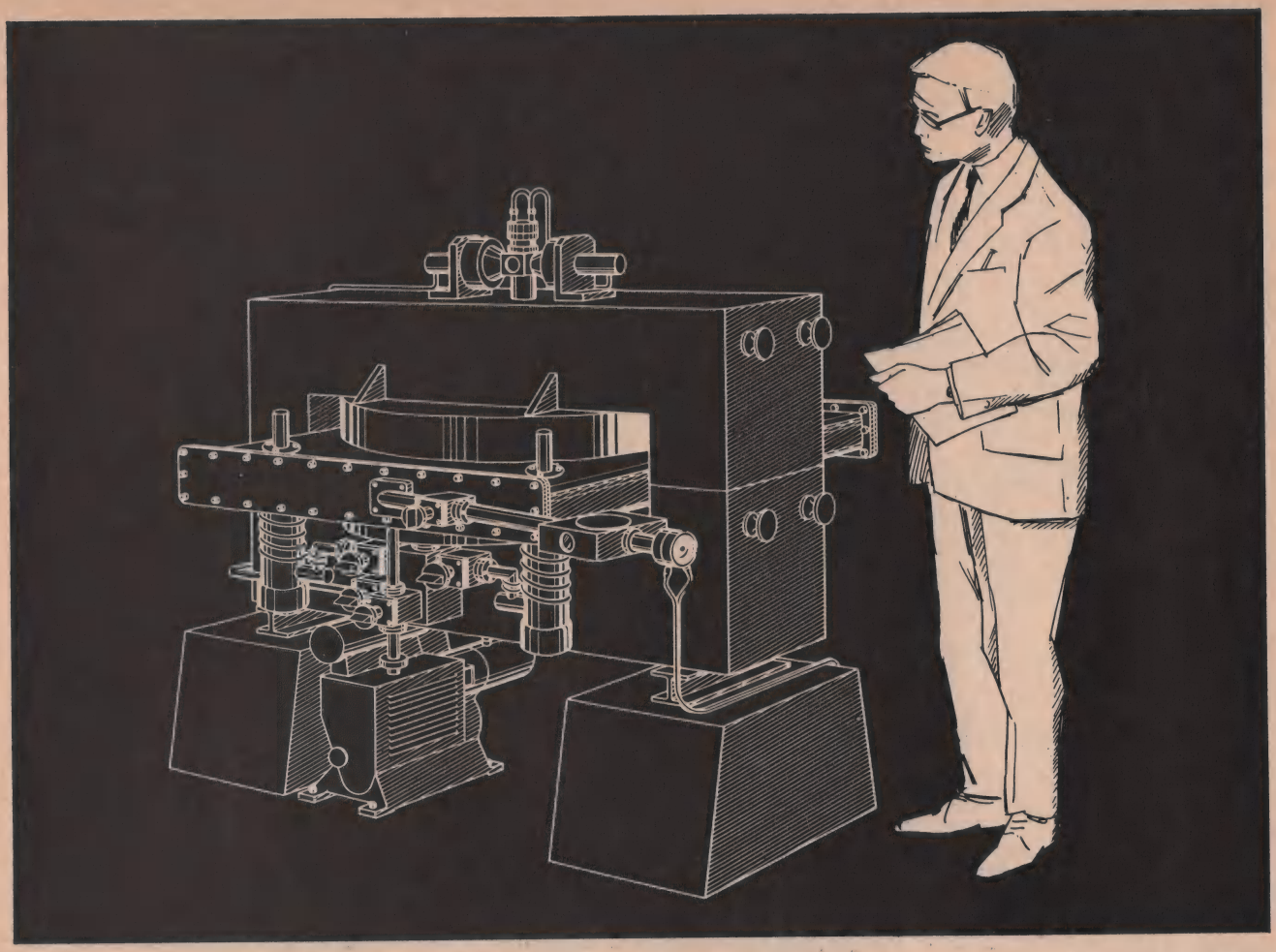
The Soviet Union has taken several long strides toward creation of a 1,000-Bev accelerator, and is now in the process of starting up a 1-Bev model of it at the Radiotechnical Institute, Moscow.

According to Academician Alexander Mints, head of the Institute, the model will be used to test design principles of the fully computer-controlled giant machine. Mints is silent as to any construction starting date for the 1,000-Bev accelerator, or what experiments will be done with it.

Studies for a U.S. 1,000-Bev machine are under way at Brookhaven and Argonne National Laboratories. At Brookhaven, John P. Blewett, deputy chairman of the accelerator department, told SCIENTIFIC RESEARCH: "I would not guess that because they are starting up the model they will begin the 1,000-Bev accelerator right away. That's still some way off yet."

Blewett said that the Russians briefly mentioned their 1,000-Bev design at an international accelerator conference over a year ago. "They told me they were under considerable pressure not to start any major project until the 70-Bev Serpukhov accelerator was ready," he said. A beam is expected from that machine next year. Blewett said a U.S. machine of 1,000-Bev would cost at least $1 billion.

Mints, who was responsible for the radio frequency system design at the Dubna nuclear physics center, revealed that the 1,000-Bev machine will have a 20 kilometer orbit, with particles entering the strong-focusing ring at 18 Bev. An automatic regulating system will correct the magnetic fields that guide injected protons through the vacuum chamber, which will be 5-7 cm



From Philips... a new generation of compact, isochronous cyclotrons which split the price barrier

Until recently, the capital outlay required for an isochronous cyclotron has been an insurmountable barrier for many scientific, medical and commercial organisations. So Philips has introduced a new range of compact models, costing something in the region of one-tenth of that required for its larger, conventional cyclotrons.

All the advantages of isochronous operation are evident in this new range, opening up exciting new possibilities in:
Activation analysis. Extremely sensitive quantitative analyses - part billion - can be performed. Where necessary, they may also be accomplished on light Z-elements. Increased selectivity can be achieved by using the variable energy model.
Short-life isotope production. Invaluable for medical diagnostic measurement and therapeutic treatment.
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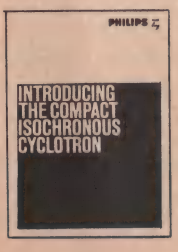
Specification. Model A is a fixed energy He^3 accelerator with a particle energy of 20 MeV. *Model B* is a four particle fixed energy accelerator with the following particle energies: 12 MeV for protons; 7.5 MeV for deuterons; 20 MeV for He^3; and 15 MeV for alpha particles. *Model C* is a variable energy He^3 accelerator with particle energies ranging from 8 - 20 MeV. All three models have the following specifications. External current 100 μA • Energy resolution 1% • Beam quality: 300 mm mrad vertical; 150 mm mrad radial • Pole diameter 28 in (70 cm). • Power requirements 100 kW • Magnet dimensions 6 x 3½ x 2½ ft (180 x 110 x 70 cm) • Weight 10 metric tons.

Further information: a brochure, giving details of the new range of Philips compact, isochronous cyclotrons, will be sent to you on request.

Philips experience in the design and construction of cyclotrons is unrivalled. Since 1948, the company has produced a variety of synchronous and isochronous cyclotrons. In every case the guaranteed performance specifications have been surpassed.



Philips,
Cyclotron Department
Eindhoven, The Netherlands

PHILIPS

Isochronous Cyclotrons

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diameter.

Imperfections in the magnetic field tend to force the protons off center but this will be corrected by a special magnet along the outside of the ring. The magnet will be controlled by a computer. Other systems will regulate the number of betatron oscillations and other conditions within the accelerator. Mints asserts that the computer system permits relatively low accuracy requirements in accelerator components.

Blewett commented that the U.S. study envisages a 1,000-Bev machine vacuum chamber of 4 by 8 cm. The computer control system is under consideration for the U.S. machine, he added.

The U.S. 200-Bev accelerator is still not yet funded, or a site selected for it. The U.S. Atomic Energy Commission rejected a proposal to drop the 200-Bev design, improve the 33-Bev AGS accelerator at Brookhaven, and go straight to a 600-1,000-Bev machine right away, although the studies aimed at the giant machine still proceed. The European Organization for Nuclear Research (CERN) has its own 300-Bev design well in hand.

New York

RETALIATION LIKELY AFTER FDA RULING ON PILL RESEARCH

Rapid, maybe legal, retaliation seems likely to follow a recent Food and Drug Administration ruling that research done by Robert A. Wilson on the Enovid birth control pill for G. D. Searle and Co. was unacceptable.

Searle shot off a strong protest to the FDA immediately after the ruling was made and Wilson was, at the time of writing, due to consult his colleagues and attorneys on future action. He had already spent a day with Administration officials in Washington trying to gather information on the ruling.

Wilson wrote the controversial book "Forever Feminine" in which, although he did not mention Enovid specifically, he referred to norethynodrel, a hormone found in Enovid but in no other birth control drug. He made several claims for this hormone, and also mentioned it in a subsequent magazine article.

The FDA ruled that Wilson was a researcher under contract to Searle, and was publicizing the firm's product. He could do research or he could publicize the product, but not both at the same time, the Administration decided.

John H. Steer, an official of the Searle company, told SCIENTIFIC RESEARCH that the FDA ruling had been protested. Wilson wrote his book and the article on his own account, Steer said. "A company investigation showed that he was not working for us," he added. "As far as I am concerned he was completely within his Constitutional rights," Steer said.

Wilson, who established the Wilson Foundation in New York to do research in cervical cancer, menopausal diseases and other related fields, is retired from medical practice. He is a licensed investigator for several organizations, said a Foundation official.

Wilson would not comment on his future course of action until he had consulted his attorneys and colleagues, he said.

Chicago

FULL-TIME STUDY FOR CREWE: RESIGNS AS ARGONNE DIRECTOR

An urge to get back to full-time research, disenchantment with a new tripartite management setup at Argonne National Laboratory and differences with the Atomic Energy Commission in Washington were behind the resignation last month of Albert V. Crewe, Argonne's director.

Albert Crewe: disenchantment leads to Argonne resignation

He told SCIENTIFIC RESEARCH: "I am going to continue with my work on high-power electron microscopes (SR, Sept. '66, 31). There are no specific projects in mind but I have a number of possibilities." He added that research is a full-time activity and is not fully compatible with the duties of a laboratory director.

Crewe is returning to the University of Chicago as a professor in the physics department and in the Enrico Fermi Institute for Nuclear Studies at the university. He has been a faculty member since 1955. For the past eight years he had held administrative positions at Argonne; initially he was director of the particle accelerator division and then became director of the whole laboratory in 1961.

No effective date was set for Crewe's resignation, pending selection of his successor. He will stay until he is replaced.

Cerrotololo, Chile

GROUPS RACE TO MAKE FIRST SOUTHERN SKIES SPECTROGRAPH

Something of a race is developing between the University of Michigan and a consortium consisting of France, Germany, Belgium and Sweden in their efforts to make the first full-scale spectrographic investigation of the cosmos above the Southern Hemisphere.

The university seems likely to win since it is moving bodily from its campus at Ann Arbor, Mich., a 24-in. Schmitt telescope for reestablishment at Cerrotololo, Chile. The telescope will be ready for work in March. The Europeans also plan to use a 24-in. Schmitt, but have to build it from the ground up on a site somewhere in Chile.

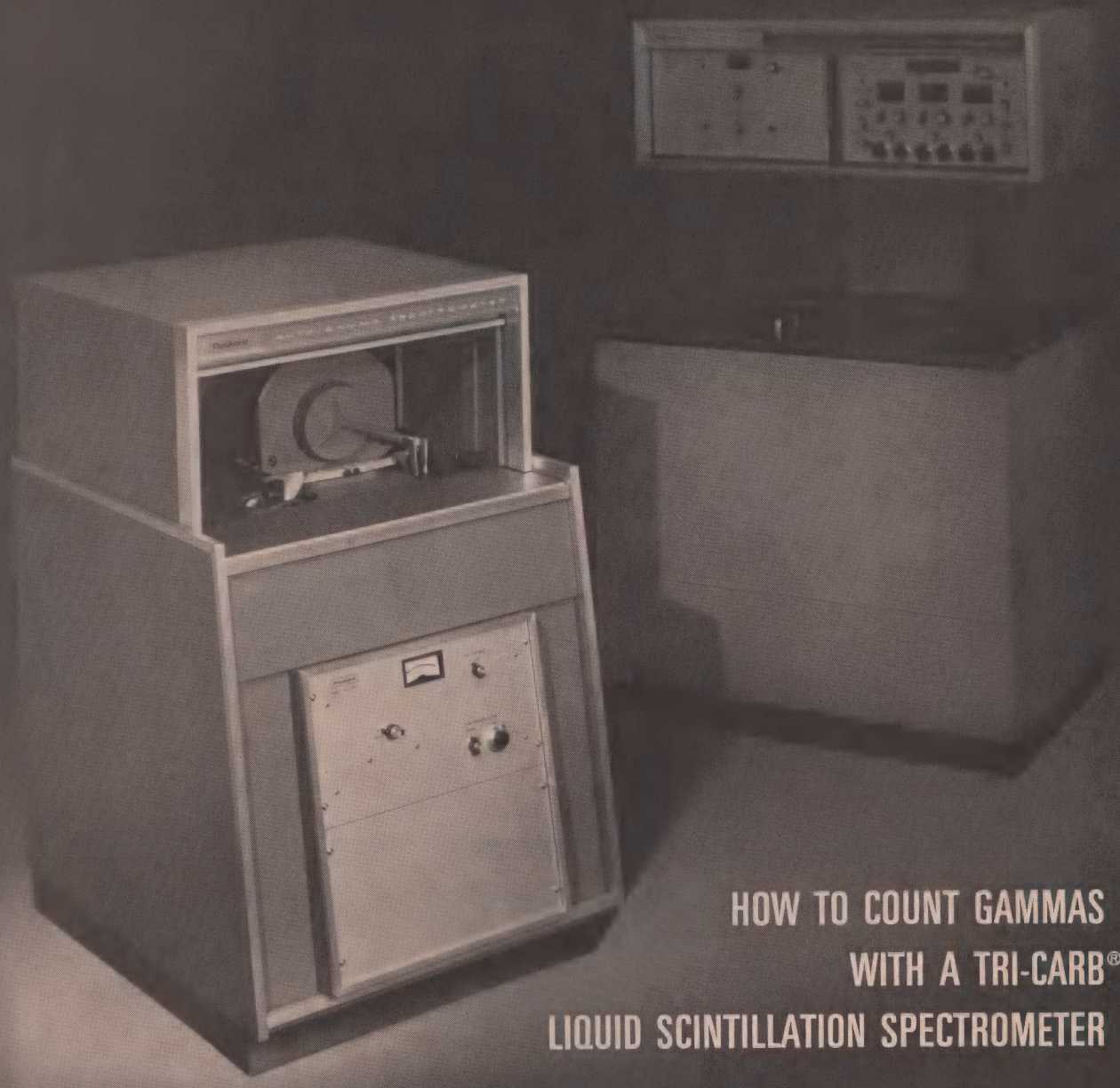
The university's research is being sponsored jointly by its own funds, by the Association of Universities for Research in Astronomy and by Kitt Peak National Observatory. A spectrographic chart of everything above the 10th magnitude will be made, with special emphasis being placed on the Magellanic Clouds.

Washington

NIH DIRECTOR'S NEW ADVISORS TO MULL SOCIAL SCIENCE ROLE

When National Institutes of Health Director James A. Shannon's new advisory committee holds its first full meeting at the end of January one of the pressing questions which could be on the agenda is this: should the NIH get more deeply involved in the social and behavioral sciences?

The question is particularly timely just now, since the National Institute of Mental Health (heretofore a "division" of the NIH and its only component in the social sciences) is splitting away from its parent to become a separate bureau of the Public Health Service Janu-



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Packard

ary 1. NIH will still have some say in NIMH clinical and lab research done at the Bethesda, Md., location, but will be generally bereft of any mission in the social and behavioral sciences.

Shannon is chairman of the eleven-man committee, drawn from universities and industry, which is designed to give top-level advice on policy and planning of the growing NIH ('67 budget: $1.4 billion.) The committee will also examine distribution and progress of current research efforts and determine NIH's influence on medical science, medical education, and related research and academic institutions.

The NIH component institutes have each had their own advisory committees for some time, and creation of the director's committee stems directly from the March 1965 Wooldridge Committee report on NIH organization.

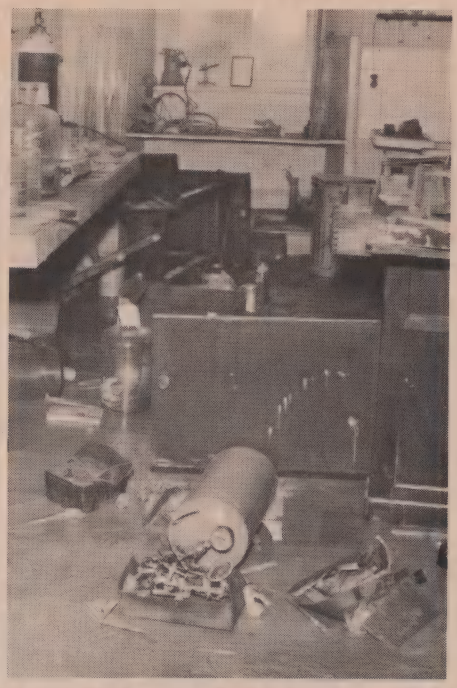
Committee members are: Philip P. Cohen, Univ. of Wisconsin; Douglas D. Bond, Western Reserve; G. Franklin Edwards, Howard Univ.; Caryl P. Haskins, Carnegie Inst. of Washington; Maurice John Hickey, Univ. of Washington; Irving M. London, Yeshiva Univ.; William D. McElroy, Johns Hopkins; V. G. Nielsen, Aerospace Corp.; Wendell M. Stanley, Univ. of California; Barnes Woodhall, Duke Univ. Medical Center; and Jerome B. Wiesner, MIT.

Washington

CANCER VIRUS A BACTERIA? AAAS TOLD IT'S POSSIBLE

Eleanor Alexander-Jackson could be in the middle of one of the most shocking and significant developments of the past half century. The bacteriologist told the AAAS meeting in Washington last month that she and others studying the Rous virus which causes fowl cancers have found this "virus" to be actually a transient form of bacterium. Rous virus from the National Cancer Institute, cultured on human blood agar and peptone broth, were proved capable of transforming into a Gram-variable, acid-fast organism probably belonging to the bacterial order *Actinomycetales*.

If this cancer virus is only one form of a polymorphic bacterial organism then once again there is raised the specter first called forth by geneticist Darlington 20 years ago, that viruses are not independent entities but only transient forms of a cellular organism.



Italian tragedy: Florence University Physical Chemistry Institute wrecked by recent floods

Florence, Italy

FLOODS IN FLORENCE RUIN TWO RESEARCH INSTITUTES

Art wasn't the only thing damaged in Florence during the recent floods that ravaged the Italian city. Two research institutes of the University of Florence were just about wiped out.

Hardest hit was the Institute of Physical Chemistry. Director Enzo Ferroni reports that instruments worth some $200,000 were a total loss. The Institute has stopped functioning until the university can raise the money to replace the instruments and repair the damage to laboratories.

Ferroni has launched an appeal throughout Europe for used research equipment to get the Institute back on its feet rapidly. When news of the damage spread, the Institute received calls from Nobel laureate Giulio Natta in Milan and the rector of the University of Pavia offering use of their research facilities and laboratories.

"Little by little we hope to get the money to rebuild our labs," Ferroni told SCIENTIFIC RESEARCH. "This will take a great deal of time because Florence is greatly damaged and whatever money there is will be needed more urgently elsewhere."

Much of the flood damaged to the Institute was through bad luck. At the time the usually placid River Arno came roaring over its banks to deluge the city with up to 15 ft of water, the Institute had moved many of its instruments to the basement because of repairs to upper stories. The university's Institute of Analytical and Organic Chemistry was also badly damaged, but most of its equipment is more easily replaceable.

London

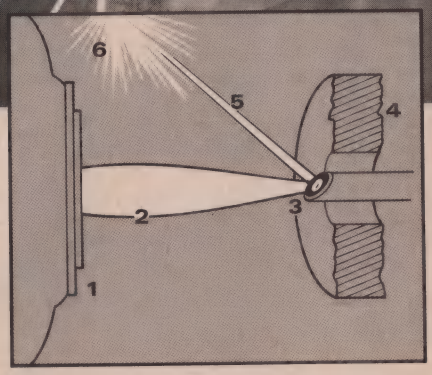
BRAIN DRAIN INVESTIGATION SET BY BRITISH GOVERNMENT

Britain's brain drain to North America has apparently reached such worrying proportions that a government investigation is to be made—after years of official unconcern.

The Department of Education & Science and the Ministry of Technology, which between them administer basic and applied research and development, have established a subcommittee of the Committee on Manpower Resources for Science & Technology to carry out the study. The Committee reported last October on the brain drain up to 1963 (SR, Nov. '66, 19).

Official figures of emigration of scientists and engineers to the U.S. and Canada since 1963 are not available, but the subcommittee will establish the present net annual outflow. It will then make recommendations in an interim report to be published by Easter.

A British company successful in pulling back U.K. scientists is Im-



350 Joules in 50 Nanoseconds

post-focused electron beam explodes steel target—energetic transients can now be studied in the lab

The photograph above shows the explosive effect of a single pulse delivered by a Febetron 705 Pulsed Radiation Source System and a Model 2029 External Beam Concentrator.

The sketch at right relates to the photograph and shows the accelerator (1) the electron beam (2) the target (3) and the electromagnet used to concentrate the beam (4). The photo also shows the central portion of the target exploding outward along the trajectory (5) toward impact on a metal support (6). In this experiment, the target was in air, with easy access to instrumentation. An energy density of approximately 70 calories/cm^2 was used. Densities to approximately 120 cal/cm^2 may be obtained by reducing the air pressure.

The experiment indicates an additional capability of the Febetron 705—the activation of high temperature and pressure transients, shock waves, spalling, chemical changes, etc. in appropriate materials. The activation time is short compared to many reaction times, which assists in separating cause from effect. Energy is used efficiently—over 60% of the stored electrical energy was transferred to the target in the experiment. Many different target materials can be used, permitting a number of high speed mechanisms to be conveniently studied in the laboratory without the complications of conventional explosives. And the beam is large enough (on the order of 1 cm^2) to facilitate many basic experiments such as generating plane shock waves. A key advantage of the post-focus is that the target may be damaged while conserving the electron beam tube.

High intensity electron beams are typical of the continuing development and acceptance of the Febetron 705 as a broad laboratory facility for chemists, biologists and physical and material scientists. There are now eight installations in seven of the world's leading atomic energy laboratories and a substantial additional number in other leading research and industrial laboratories. A principal reason for this world-wide acceptance is the reliability and reproducibility of the 705's performance: energy to ±4% rms for targets 10″ from the tube as in the experiment above; timing to ±50 nanoseconds (standard) and ± 5 nanoseconds (special). Such reproducibility makes it possible to define and measure the beam characteristics in detail—both in our own and in customer laboratories. This helps new installations to become productive quickly, since yesterday's dosimetry can be used in tomorrow's experiment and results can be compared and accepted between laboratories.

The output of the Febetron 705 has recently been increased to provide an accelerating potential of 2.3 MV. Electron beam energy near the window is 400 joules/pulse by calorimetry. X-ray output at 12″ from an external target is 25 roentgens/pulse. Time-tested, performance-proven, the Febetron 705 is available with routine production delivery. For detailed information request Catalog C-11, revised Sept., 1966, and Product Bulletin P-8, which describes the Model 2029 External Beam Concentrator.

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perial Chemical Industries. It recently revealed that since 1960 it has persuaded more than 100 scientists to return home to ICI jobs.

Washington

PATENT SYSTEM CHANGES URGED BY PRESIDENTIAL COMMISSION

A plan to revolutionize the slow-moving U. S. patent system and set it in a position of world leadership will be placed before the 90th Congress.

The recommendations, prepared in 18 months by the President's commission on the patent system, are now in the hands of acting Attorney General Ramsey Clark and Presidential Science Advisor Donald F. Hornig. They and Secretary of Commerce John T. Connor will send a report on the recommendations to President Johnson, and he in turn will send to Congress the proposed reform legislation.

At the heart of the report, prepared by Texas University chancellor Harry Huntt Ransom (SR, Oct. '66, 24), New York Judge Simon H. Rifkind, Patent Commissioner Edward J. Brenner and others, are these recommendations:

- issue patents on a first-to-file basis, making applicants responsible for knowing all prior inventions and developments worldwide.
- provide for optional deferral of patent examination.

These two ideas would knock away the main obstacle to patent progress in the U.S. They would end the present practice of automatically starting an exhaustive search by patent officers of the world's patents and technical literature to ensure that an application in fact represents an innovation. This has piled up nearly 250,000 applications. Deferring search would enable an inventor or company to opt for a fully-searched, iron-clad patent or a faster, cheaper patent on which search is deferred until a challenge develops.

Other recommended changes were:

- publicize the existence of supposed new technology by automatically printing patent applications within two years from filing date.
- allow anyone to challenge a patent application by giving U.S. Patent Office experts a "relatively high fee" to turn over all claims to previous developments that could invalidate the original claim.
- require the loser of a patent challenge to pay all litigation costs, and if necessary create the post of civil commissioner to hold pretrial hearings where patent suits pile up.
- allow treble damages in some infringement suits since publication of applications could be considered an invitation to license for royalties.
- stretch protection to 20 years.

Ann Arbor, Mich.

PUREBRED FROG COLONY BEGUN AT UNIVERSITY OF MICHIGAN

The sound of croaking bullfrogs is becoming increasingly noticeable in busy downtown Ann Arbor, Mich. The reason is a project, now getting underway at the University of Michigan campus there, that has never been tried outside Japan before — breeding "pedigree" frogs by the thousands for embryological research.

The frog colony is being built up along the lines of mouse colonies. Laboratories across the U.S. will be able to obtain pure strains of frogs, salamanders and other amphibians when the Michigan colony is up to full strength some time this year.

Heading the project is George W. Nace, who plans to have more than 10,000 frogs available. At present he has over 1,000 bullfrogs, leopard frogs, green frogs and wood frogs, and some 10,000 tadpoles. With careful health control and isolation periods he is managing to avoid the diseases that have ruined previous efforts to establish frog colonies.

Frogs are already supplied to laboratories by the millions through dealers, but the embryologist using them has laboratory animals of constantly varying genetic background. In using purebred frogs from the University of Michigan the researcher always has animals of constant known genetic background. Mice can be bred quicker and easier than frogs, but they only produce a small litter whereas frogs lay up to 4,000 eggs at a time. Each egg is far bigger than the mouse egg and can be studied much more easily. The mouse eggs has to be extracted from the animal and then replanted, but the frog egg is not restricted in this way.

The only other place where frog colonies have been established is at the University of Hiroshima, and there has been cooperation between the two universities in setting up the Michigan colony.

Chicago

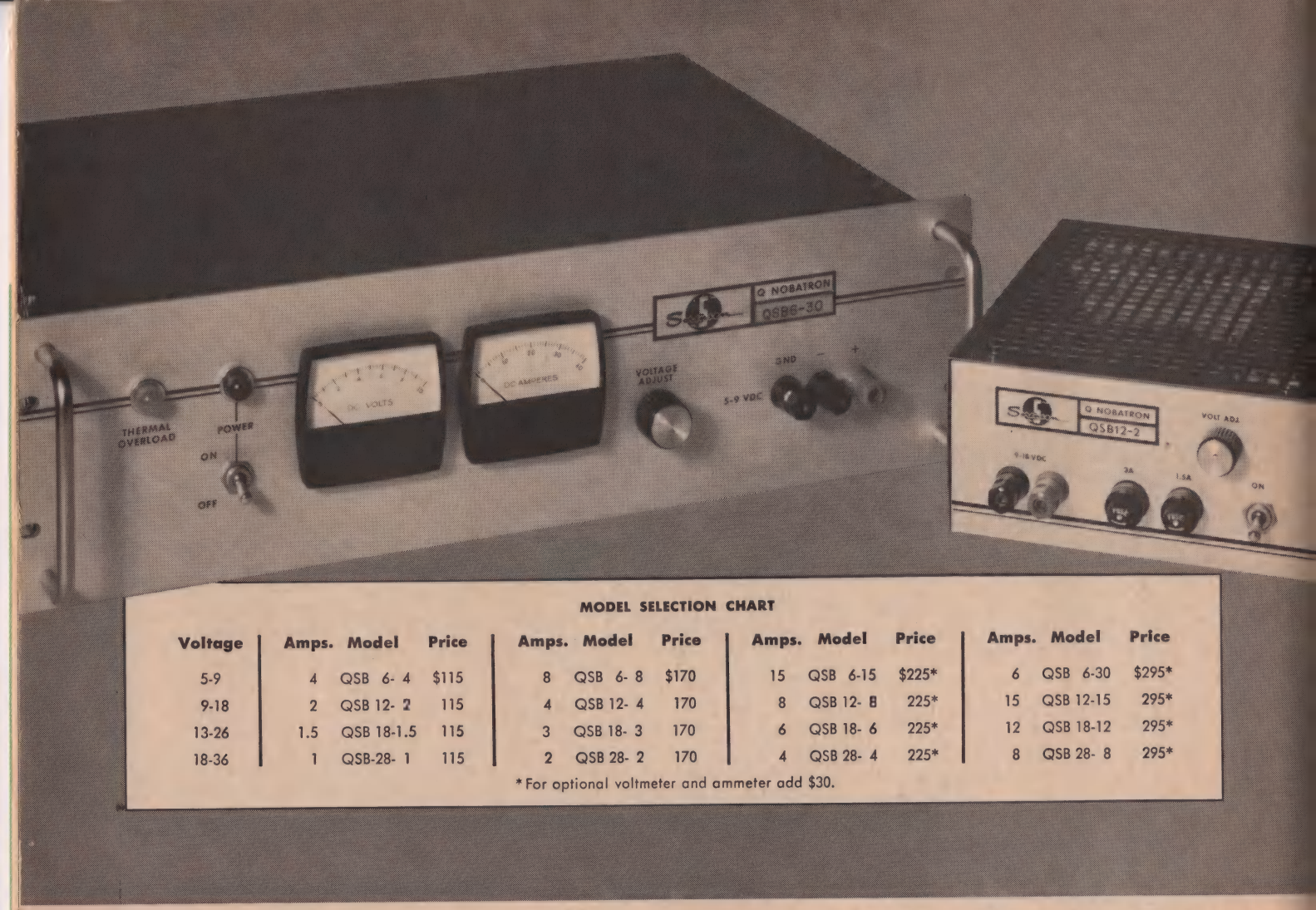
STAMLER FIGHTS LEGALITY OF UNAMERICAN ACTIVITIES GROUP

Jeremiah B. Stamler, Chicago heart-research scientist, has won a round in his court challenge of the Constitutionality of the House Committee on Un-American Activities.

The U.S. Circuit Court of Appeals, in a two-to-one decision, ruled that suits filed by Stamler and two other Committee witnesses raise "a substantial Constitutional question" that should be heard by a three-judge panel in Chicago U.S. District Court. The Appeals Court ruling vacated orders by a U.S. District Court judge dismissing the suits.

The court case grew out of 1965 Committee hearings when Stamler, his research assistant Yolanda Hall and a third, unconnected person, refused to testify on alleged communist activities in Chicago. The House of Representatives then cited the three for Contempt of Congress (SR, Dec. '66, 9).

A grand jury hearing on evidence compiled by the U.S. District Attorney's office has been postponed. Sources close to Stamler said the latest court action "solidified" his position as director of adult health and ended speculation that Stamler would be fired.



MODEL SELECTION CHART

Voltage	Amps.	Model	Price	Amps.	Model	Price	Amps.	Model	Price	Amps.	Model	Price
5-9	4	QSB 6- 4	$115	8	QSB 6- 8	$170	15	QSB 6-15	$225*	6	QSB 6-30	$295*
9-18	2	QSB 12- 2	115	4	QSB 12- 4	170	8	QSB 12- 8	225*	15	QSB 12-15	295*
13-26	1.5	QSB 18-1.5	115	3	QSB 18- 3	170	6	QSB 18- 6	225*	12	QSB 18-12	295*
18-36	1	QSB-28- 1	115	2	QSB 28- 2	170	4	QSB 28- 4	225*	8	QSB 28- 8	295*

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WASHINGTON SCIENCE OUTLOOK

ANOTHER ROUGH YEAR FOR SCIENCE BUDGETS

Washington officials working on the Federal budget to be sent to Congress this month say the National Science Foundation is in for another rough year. From the hints they are dropping, it may be the third straight year in which NSF has tried and failed to push its budget over $500 million.

In fact, they see a rough year for science budgets in general—not alone because of Vietnam and other pressures for Federal money but because these pressures have come when the dramatic growth in Federal science funding had already begun to lose its momentum.

Thus, there is widespread agreement with the opinion of Charles Kidd on page 22 that the growth curve of Federal funding for basic research will continue to level off—if not flatten out. The 1965-66 increase is estimated at close to 15 percent and the increase in 1967 over 1966 is estimated at about 10 percent. A further decline is expected in fiscal '68 (which begins July 1).

BUT SOME PROGRAMS MAY BUCK THE TREND

Bucking the trend will be the budgets for social medicine, mental health, community and environmental health programs and the like. Administration officials see this as one likely prospect to flow from the reorganization of the U.S. Public Health Service and the new emphasis this gives to environmental health. These budgets are expected to rise.

REUSS SUBCOMMITTEE SETS ANOTHER FULL SCHEDULE

Hard on its busy year in 1966—four hard-hitting reports issued on science—the Reuss Research and Technical Programs Subcommittee of the House has no less than three sets of hearings scheduled for early in the new Congress. Last year, the Reuss group investigated and issued reports on: U.S. financing of research done in other countries; management of medical research on aging; how the nation's privately-sponsored r&d is allocated and how the nation's scientific manpower is employed; and management/mismanagement of government laboratories. In its first year of existence, 1965, the subcommittee had issued its widely-read report on conflicts between the Federal research programs and the national goals for higher education.

Kicking off this year's schedule are hearings early in February on social-science research within the U.S. (as against overseas, which a Senate subcommittee headed by Sen. Harris plans to go into). These will be followed by hearings on the government-/laboratory situation, then hearings on government decision-making in its r&d programs.

VIVIAN WEIGHING BID FOR RE-ELECTION IN '68

Michigan Democrat Weston Vivian, the brilliant, young Congressman from whom great things had been expected for science until he was defeated for re-election in November, has been wondering whether to run again for Congress in 1968. Vivian had taken a substantial financial loss in order to get a seat on the Daddario Subcommittee of the House Science and Astronautics Committee after his election in 1964 (SR, Oct '66, 21), only to lose his bid for re-election by 2,500 votes in the nationwide Republican landslide Nov. 8. With a strong Democratic presidential race in 1968, it is conceivable he could come back.

In the meantime, he has had offers from his former firm, from other companies, from several universities and from the Johnson Administration (science posts which he prefers not to specify). "Faced with such a diversity of opportunities," he complained last month, "it is somewhat distracting."

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U.K. research funds crisis mirrors U.S.

Almost as though he were holding a mirror to the U.S. basic research funding crisis, Britain's Sir John Cockcroft—during a recent lecture visit to Canada—gave his views on the way to handle the same problem now facing U.K. science.

His advice: face the fact that basic-research budgets—as a part of r-&-d generally—are not growing as fast as they did over the past decade, that science faces an ever-tightening squeeze on funds from government, and that there is a great need for better selection of projects and programs to use the money that *is* available to better effect.

As Master of Cambridge's new Churchill College, Sir John is as strategically placed as anyone on the British scene to assess clearly the budget crisis. For he is at the same time a university-based scientist and a party to policy decisions in the U.K. Atomic Energy Authority and the Science Research Council. He left Harwell (U.K. AEA's research center) in 1959 but though no longer a full-time director of the AEA he continues to function as one of the "five knights" who help formulate British nuclear policy. He is also a member of the National Institute for Research in Nuclear Science and chairman of two key SRC committees.

Sir John Cockcroft: Greater selectivity in rising squeeze on funds

BIG AND LITTLE SCIENCE

Sir John's sympathies for the university researcher are quite apparent. He said that although Big Science and Little Science had lived side by side so far without serious clashes, their future juxtaposition could be menaced by budgetary considerations.

He remarked that there are in Britain no counterparts of the U.S. President's Scientific Advisory Committee, Office of Science & Technology, or science advisor to the President. The recent British appointment of Sir Solly Zuckerman as scientific advisor to Prime Minister Harold Wilson, said Cockcroft, will lead toward a large-scale advisory service. But he added: "Any cluster of advisory bodies on science manpower and economic developments should be at cabinet secretariat level.

"Whatever advisors have the ear of the Prime Minister," he explained, "will have to argue the case for fundamental research in principle, while at the same time applying some form of cost-benefit analysis in order to establish a yardstick to measure new projects submitted by the proponents of Big Science."

If cuts are necessary, where are they to be made? From Big Science, with its prestige projects of national importance? Or from Little Science, with its multiplicity of basic research projects going on in universities all over the U.K.? Selectivity and cost-benefit analysis are the keys to the problem, Cockcroft declared. He went on: "As reasons for substantial support for basic research, the scientists will undoubtedly advance the fact that it is the primary source of new knowledge about the physical and biological world and that groups of basic scientists represent a great reserve of strength for mobilization during emergencies."

According to Sir John, one of the main troubles with cutting down budget growth is that many of the Big Science projects are in international organizations, such as the European Organization for Nuclear Research (CERN). "Suppose that the politicians decide we should cut back to 6% a year," he said. "We can't control the international amount, so all the cutback will fall on our small science." He pointed to the difficulty of exercising control on CERN because the U.K. has only one vote among twelve when discussing the budget.

But CERN is pushing even harder now for more spending. The proposed 300-Bev accelerator will cost $390 million and have an operating cost of $90 million a year. Britain will have to pay its share and the machine might even be sited in Britain, near Cambridge. Another ambitious plan is the $20-million high-intensity neutron beam reactor.

The present two-year doubling time of computer power has already outdated the concept of one national computer laboratory—Atlas at Harwell. The British now hope to have at least three regional computer centers in two years' time, equipped with the most powerful machines available.

SPACE BUDGET CONTINUES UP

Space expenditure is taking some $35 million a year and is rising rapidly, with Britain tied to the European Space Research Organization (ESRO). Discussions with Australia are now aimed at building a 150-in. optical telescope there, and Cockcroft noted that the next generation of radio telescopes will be in the multimillion-dollar range.

"There is a gathering consensus that before Britain undertakes any new international project there will have to be a clear understanding from London that this spending will not be at the expense of small science," said Sir John.

But while British scientists will undoubtedly continue to make a strong case for continuing increases in the proportion of GNP devoted to basic science, they now realize there is no longer an open-ended situation—no matter how prestigious the projects being proposed are. Grants for large-scale science already total some $90 million a year (including $40 million for nuclear physics, $35 million for basic space research and some $10 million for computers), while grants to universities and independent research units from the various research councils add up to more than $50 million. Basic research spending is roughly a tenth of the total r-&-d pie, as it is in the U.S.

There seems to be no easy way to cut down the growth rate of small-

scale science. The university population is expanding at 3-4% a year and the proportion of postdoctoral researchers is increasing even faster. Furthermore, the cost curve for equipping a research worker is rising at 5% annually. The $150 million the University Grants Committee distributed in 1965 sufficed to cover little more than salaries and wages, with perhaps $8.5 million left over to equip 10,000 research workers. The research councils supplement this sum with a grant of $500 to university departments for each student judged on research training, and larger grants for projects of special importance.

But the Science Research Council is also responsible for grants to build the accelerators, reactors, computers and telescopes. It must weigh the requests for grants of the individual boards (nuclear physics, astronomy and space, science and technology) as well as those of the Rutherford Laboratory at Harwell and the other big spenders.

Cockcroft feels that despite the 12-13% growth pattern established for small-scale research, "we need not be unduly troubled by the financial burden of adding another $50 million during the next five or six years to the grants from research councils to universities."

FRANKNESS ON BIG SCIENCE

Dealing with big science is another matter: the benefits from "programmatic fundamental research" (a more dignified title than "Big Science," says Cockcroft) are likely to be multidimensional and to involve criteria other than those of "intrinsic scientific merit." He argues for greater frankness in identifying these non-scientific factors.

"If an important reason for supporting certain types of programmatic fundamental research is their ultimate relevance to defense, or foreign policy, or international prestige, then this should be clearly stated, in order to stimulate a fruitful debate on alternative and possibly less expensive means of achieving the same ends," he said.

Sir John is equally wary of the "technological" argument in the total analysis of "benefit." He says that it may be necessary to look again at costs of a project, if this argument is pursued, to see if there is adequate provision for the costs of technological exploitation as well as more immediate capital, operating and research costs.

U.S. science funding outlook in '68: Up . . . but at slower rate

One evening in November as the Federal budget for Fiscal 1968 was being drafted, Dr. Charles V. Kidd walked into his office at the White House Annex with the weary air of a professor after a tough day of teaching a difficult subject to skeptical students.

Kidd, Executive Secretary of the Federal Council on Science and Technology and a member of Donald Hornig's Office of Science and Technology in the White House, had been involved in one of many sessions of tough negotiations with the Budget Bureau over Federal science expenditures. The meeting had dealt with the increasingly perplexing and painful question of how much money to spend on scientific research in time of war, inflation, heavy domestic outlays in other fields and intensifying political pressure from the 1966 elections.

It had not, apparently, gone too well for science at that session; but if Kidd was weary, he was not discouraged.

Like a professor dedicated to his subject and confident that his class will come through in the end, Kidd counsels patience and perspective on the part of the scientific community. He acknowledges that the new budget only continues the leveling-off trend of funds for research which has characterized the budgets of the past four years. He emphasizes, however, that while the "slope of the curve" representing research money is being reduced, it nevertheless remains an upward—not a downward—slope.

UP—BUT HOW FAST?

Says Kidd: "The dollar amounts for both applied and basic research will rise into the foreseeable future. The big question concerns the relative rates of increase as between the two. We're swinging toward application, but we're certainly not heading for any dismantling of basic research. The basic research people are by no means impotent in getting their points across. No matter what happens in this budget, we will still have a very strong program of research, and the scientists will have a strong voice. The big thing is that we finally have something we can call a system for using the voice."

The tissue of that system consists essentially of OST, the National Academy of Science (NAS) and the governmental National Science Foundation (NSF). Its cells, however, are the high-quality, comprehensive reports already written and those being planned by and for NAS' Committee on Science and Public Policy—COSPUP (SR, July '66, 12). The reports describe the strengths and diagnose the deficiencies of the disciplines, set forth their opportunities in an equation with future financial support needed from the government. NAS sends the reports to Hornig, they are reviewed by the Federal Council and sent over to NSF, then NSF oversees their review by committees of officials representing the government agencies directly involved in the respective fields of research.

Following interagency distillation, the reports wind up back at OST, thus becoming a force at the apex of governmental planning and funding of research endeavors. As OST went into battle for science on the fiscal 1968 budget, it had in hand COSPUP-interagency reports on chemistry, computers and ground-based astronomy, with the expectation that one on physics would be available before the blue pencils were laid away this year.

The COSPUP reports get high marks for quality at NSF and OST, and have been received gratefully as tools. Yet they have encountered criticism for taking a "blue-sky" approach to federal support of scientific research. They are regarded by a number of scientists-in-government as placing too much emphasis on dollars in bulk, not enough on qualitative analysis of how the dollars should be distributed within the disciplines.

"There is an awful lot of nonsense in all the talk about 'the growth of the curve,'" says one NSF official. "The curve only makes sense when you decompose the aggregate amounts. The important thing is that we're producing more researchers and more capable researchers than ever before, and we will continue to do so. And for the first time, we are producing models for thinking about how to attain growth."

Officials of NSF and OST caution against overenthusiasm for the possible results of the COSPUP reports, if not for their quality and value. The somewhat defensive atti-

Final FY '67 'box-score' for federal r&d budgets

R&D budgets for '67—By agency

	(10^6) '66	'67
NASA		
Research and development	4,531.0	4,245.0
Facility construction	60.0	83.0
Administrative operations	584.0	640.0
DOD		
Research and development	6,621.1	6,983.9
AEC		
Reactor development	468.1	465.3
Physical research	236.0	255.3
Biological and medical research	83.0	86.0
Isotope development	11.6	14.3
Dept. of Agriculture	140.1	145.5
NSF	480.0	480.0
HEW (NIH component)	1,244.4	1,412.9

NIH research funds, probable allocation

Institutes	(10^6) '66	'67	Grants '66	'67*
General Medical Sciences	61,256	75,179	1,754	1,700
Child Health & Human Development	38,081	42,291	1,113	1,200
Cancer	67,946	77,550	1,583	1,500
Mental Health	85,230	90,131	1,596	2,000
Heart	96,469	106,374	2,153	2,300
Dental Research	11,008	15,126	310	400
Arthritis & Metabolic Diseases	84,180	92,635	2,676	2,800
Allergy & Infectious Diseases	43,466	52,006	1,332	1,400
Neurological Diseases & Blindness	63,890	74,797	1,540	1,700

*estimate

How NSF has allocated its '67 budget

	(10^6) '66	'67
Basic Research Project Grants	157.8	174.3
U.S. Antarctic Research	8.4	7.6
Arctic Ocean Research	0.0	0.1
Weather Modification	1.8	3.0
International Indian Ocean Expedition	1.1	0.0
International Year of Quiet Sun	1.6	0.8
Ocean Sediment Coring	5.4	1.3
Deep Crustal Earth Studies (Mohole)	17.0	1.0
U.S. Japan Cooperative Science	0.7	0.5
Biological Sciences Research Facilities & Instruments	4.0	2.5
Oceanographic Research Facilities	2.4	2.7
Physical Sciences Research Facilities	6.5	5.8
Atmospheric Research Facilities	0.8	0.8
Specialized Social Sciences Research Facilities	1.2	1.0
Engineering Research Facilities	0.8	0.5
Chemistry Instruments	2.4	2.5
Astronomical Research Instruments	1.4	1.0
University Computing Facilities	8.9	11.8
National Research Centers	23.0	28.6
Fellowships and Traineeships	44.5	45.9
Institutes for Teacher Training	40.5	39.4
Course Content Improvement	15.6	18.7
Instructional Equipment for Undergraduate Education	7.7	4.0
Other Science Education	124.3	121.6
Institutional Grants for Science	14.5	14.5
Graduate Science Facilities	16.2	30.3
Science Development (now University Science Development)	36.4	35.6
Departmental Science Development	0.0	15.0
College Science Improvement	0.0	10.0
Science Information Coordination	11.6	10.8
International Science Activities (including Information Exchange)	0.9	0.9
Studies of National Resources	2.0	2.5
Program Development and Management	13.1	14.7

tude discernible at NSF and OST is derived from their scientists' need to balance what presumably should be done, as expressed ideally by COSPUP, with what can be done, as expressed realistically by the Budget Bureau.

Mixed loyalties are apparent at NSF, too. Wayne Gruner, head of the Foundation's physics section and Chairman of the Interagency Committee which reviewed the COSPUP report on the discipline, contends that unless federal research funds soon can be graphed more vertically, "there will have to be some kind of major readjustment within the profession of physics because what's happening now reflects a heading off of a trend, since World War 2, to which the whole profession had become geared."

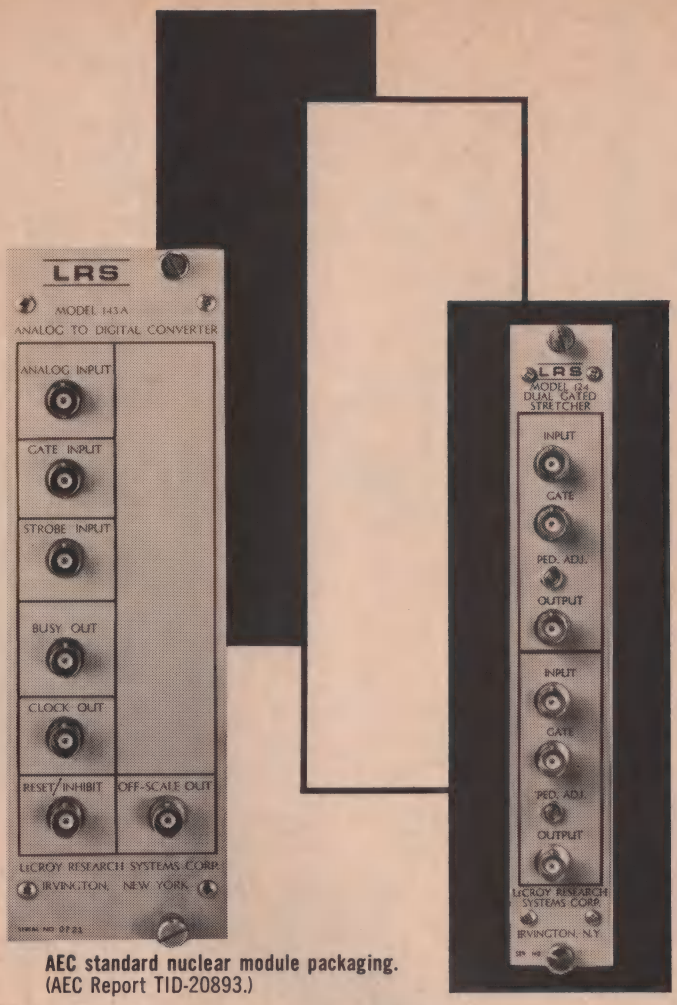
Still, Gruner, whose background as a theoretical physicist endears him to basic research, warns against perpetuating, in the physics field, "one of the great misconceptions: that whatever is wrong is the fault of the federal government."

Gruner and NSF's Geoffrey Keller, who supervised the interagency review of COSPUP reports on chemistry and computers, take a "who-knows" approach to the relative values of science and sociology, at any given time, under any given set of circumstances, to the national need. Thus they exemplify the scientist-in-government who finds it increasingly necessary to regard science as part of the community, not as a community apart, and who has difficulty assigning financial priorities within the nation's scientific-socioeconomic matrix.

Keller, noting signs that Congress is demanding better arguments and more specifics to substantiate research spending, would be "surprised if we pick up the old rate of growth again, even if the war in Vietnam ends."

Federal support of basic research "seems to have levelled off to $1.5 billion to $2 billion a year," he says. He expects it to stay that way, barring the unforeseen.

Clearly, COSPUP has been and will continue to be, a major factor in developing the voice of science in Washington. But that voice is but part of a chorus which tends to disharmonize at budget time and within which it is difficult to find a standout soloist. As Kidd puts it: "We want the best in science, but we also want people educated, we want decent cities, we want everyone to be able to live decently and we have to fight the war in Vietnam. Sure, it's a big problem. We'll just have to work it out."



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THE BUDAPEST

THE expectation of finding the fossil remains of any primate, it has been estimated, is of the order of one chance in 10^{15}—much less than the chance that the burrowing anthropologist will some day be struck by lightning. But undismayed by dreary numbers, they continue with roving curiosity to plumb the gray Cenozoic muck—the ooze and gravel of the Age of Mammals—seeking bone-by-bone for hoary notes still left on the writing pad of evolution.

This resolute enterprise was rewarded in a quarry just west of Budapest about a year ago when archeologist Laszlo Vertes (Hungarian National Museum) discovered a fragment of a human skull; now after a year of measurements and meditations this skull is believed to be a 500,000-year-old member of our own family, *Homo sapiens*—thereby doubling previous estimates of our historical span.

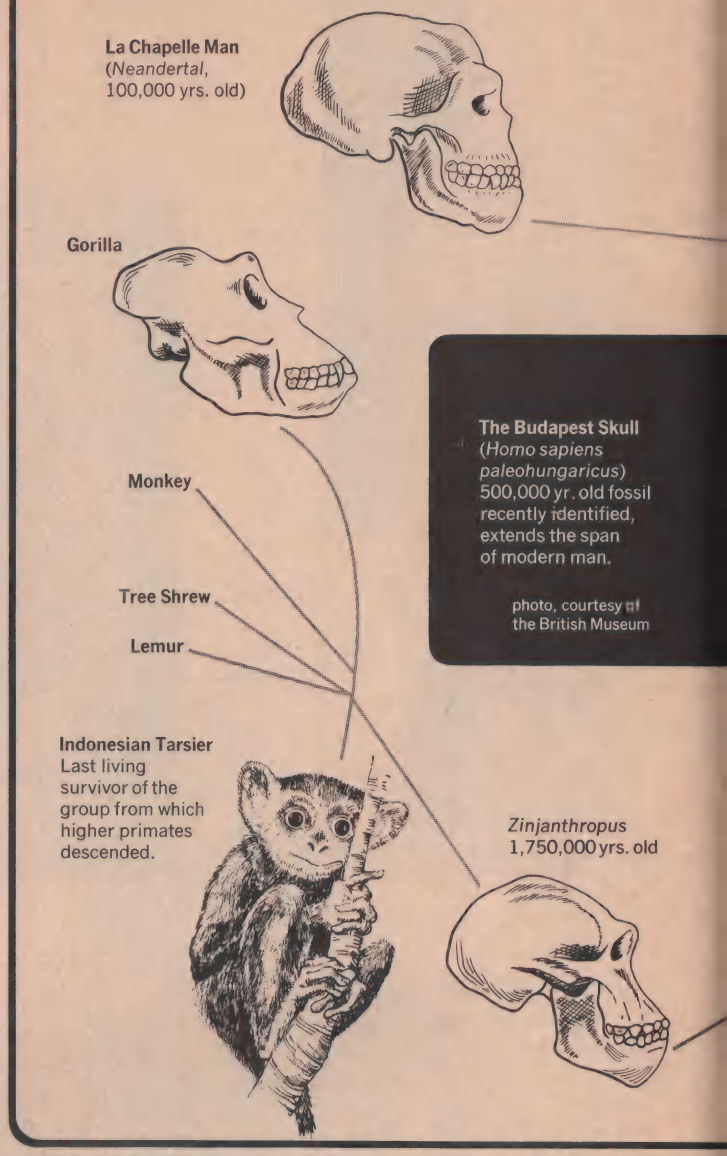
The Budapest skull could disrupt what was thought to be a well-ordered scheme of man's genealogy, for this calcareous intruder is judged to be anatomically closer to modern man—yet possibly older!—than *Homo erectus*, the fossil man thought by most anthropologists to be the immediate ancestor of modern man (see Fig. 1). According to popular current sketches of our family tree both *Homo sapiens* and *Neanderthal* derived from a common forbear, *Homo erectus*, at some point approximately 200,000 years ago.

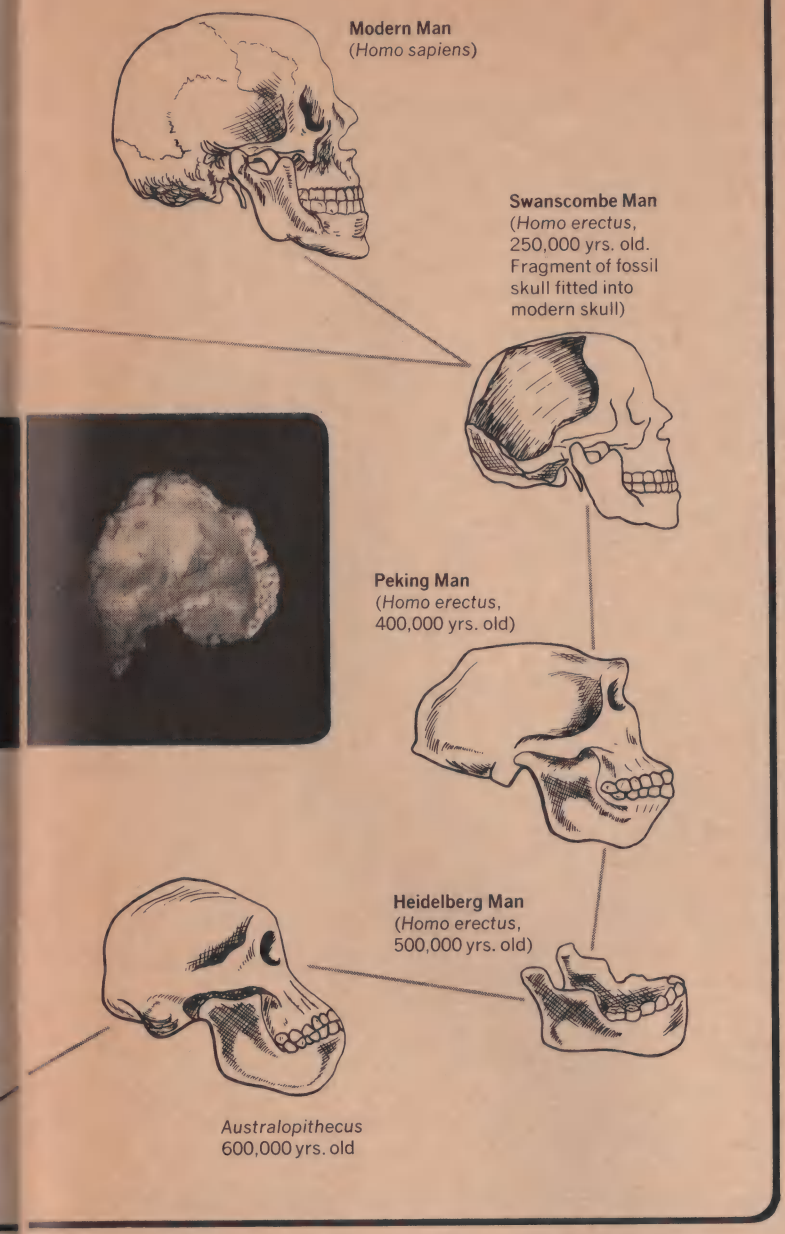
The identification of this unexpected visitor was made by Hungarian anthropologist Andor Thoma of Kossuth University (Debrecen). His analysis of the specimen—an almost complete occipital bone (which covers the posterior portion of the primate skull)—revealed a cranial shape and capacity even more closely related to that of modern man than any member of the *erectus* species.

Repercussions and ramifications. While this new development requires modification of man's family tree—placing a figure much like modern man as a contemporary of, or even predating (since there is no evidence to the contrary) *Homo erectus*—there is confidence among certain physical anthropologists, e.g., Kenneth Oakley of the British Museum and William Howells of Harvard, as well as Thoma, that there is still no contradiction of modern theories of the evolution of man. Noticeably avoiding mention of the possibility that a *sapiens* grade of man appeared prior to *erectus*, Howells concludes only that what we may be seeing is a trail going back straight to Heidelberg man (see Fig. 1), a fossil believed to be the first of the *erectus* breed to struggle in the glacial tides some 500,000 years ago.

The implication may be that *sapiens* is now seen to derive from Heidelberg man, sometime before the Mindel glacier plunged down across the northern land masses, rather than at some time afterward from Swanscombe or Steinheim man (previously assumed to be the link between *erectus* and *sapiens*). But this puts a great deal of pressure on what is, from casual inspection, a very weak point in the theoretical structure physical anthropologists have built: the only description we have of this early *erectus* family is a single cipher—a huge, rather apelike jawbone retrieved from a sandpit near Heidelberg, Germany, in 1907—and in the absence of more bone specimens of the period it would be impossible at this time to link the Budapest find with its fossil colleague from Heidelberg.

The Leakeys' theory. Louis and Mary Leakey, who have been exhuming the remains of our antique relations from a gorge in East Africa for several years now, see the *sapiens* grade of man as having ascended on a path which is quite independent of the *erectus* line. The Leakeys fix the





Before the recent discovery of a 500,000 years old fragment of the skull of a *sapiens* grade of man, modern man was assumed to have evolved from *Homo erectus* about 250,000 years ago, as shown in the family tree above. Now however Heidelberg Man could be *Homo sapiens'* direct forbear. All this assumes that our reading of the fossil record is accurate—but there is reason to believe that it may not be. The use of bone measurements to detect man's origins has always been severely criticized.

SKULL

origin of *sapiens* at *Homo habilus,* a relative and contemporary of Zinjanthropus (see Fig. 1), about one million seven hundred and fifty thousand years ago. *Habilus,* the Leakeys maintain, was an advanced primate, estimated to be about four feet tall, who stood, ran and walked on quite human feet, although he did not have a human face.

Just what the Budapest discovery means for their contention remains unresolved. This may be an even more difficult question for Leakey to deal with than it is for those who look to Heidelberg man for a connection, since the Leakeys' suspect, *habilus,* was a man who didn't look much like one! His brain case measured a slim 685 cc, about half that of the Budapest skull and modern man, and he much more nearly resembled the gorilla-like Australopithecine men than did *erectus.*

CRITICISM OF CURRENT METHODS

As mentioned at the outset, the prospects for finding any early primate remains are dim—but the prospects for finding man's remnants are even more depressing, for, geologically speaking, man has been a very rare creature until only recently. Consequently the idea that human prehistory can be deduced from the observation of fossil bones could be a delusion when viewed from this practical point of view.

The feeling that the prevailing methodology of physical anthropology will prove futile originates from other reservations which are closely related to the projected infrequency of turning up data. These criticisms extend to the very foundation stone of this field of study, the methods of *anthropometry,* the elaborate construction of bone and skull measurements which are used to classify and relate different species.

The use of skeleton measurements to detect the pattern of man's origins has been subjected to severe criticism for a good many years, although only by a small minority of individuals qualified in the subject. Biochemist-anthropologist William Boyd (Boston U. Medical School) and geneticist Theodosius Dobzhansky (Columbia U.) have been among the leading critics of the notion that bone measurements, which form the basis of the classification scheme of modern anthropology, are sufficiently revealing and reliable to relate different species.

In addition to this fundamental objection, Boyd contests what is probably the dominant concept of anthropology, that mankind originated in a single place and from a single ancestor (the place of origin is thought to be Asia or Africa, with perhaps an edge given to Africa). Instead he has suggested a re-examination of an old idea, that man's origins are probably "polyphyletic," from orang-like, gorilla-like and chimpanzee-like ancestors.

Boyd *(1)* has formulated the problem concisely by asking: "Was or was not early man more homogenous than present-day man taken as a whole?" If mankind stems from a single time and ancestor then it is possible that early man was homogenous, that is, individual members of the race resembled one another rather closely. However, if modern man derived from the fusion of various *hominoid* (resembled man) groups at dif-

ferent times then early man may be as diverse as modern man, manifesting an inconvenient variety of structural characteristics. If the second possibility is more likely, then it is difficult to remain optimistic that the brief glimpses into the past afforded us by the skimpy fossil record can clarify the nature of the origin of the human race.

APPROACHES TO THE STUDY OF MAN

The trail of man's evolution stretches behind us for more than a million years, vanishing rapidly in whirling mists and sunless caves where we listen for whispering echoes. Searching into the alien landscape of our shambling ancestors most of our knowledge is derived from puzzling over their bones and tools which date to the last half of Ice Age, the past million years of alternating cold and warm periods caused by the advance and retreat of glaciers in the northern hemisphere. From these pitiable scraps and remnants—splintered, ground and churned in the vast shrouds of ice which have ploughed across the northern continents four times already during the glacial epoch in which we still live—physical anthropologists have woven fragments of questionable fact and disputed theory into a fragile record.

In order to carry out a classification scheme for relating species, the physical anthropologist must be able to recognize some stable, species-specific properties in fossil remains. Here the anthropologist has the same task as the taxonomist, for both aim to classify different species which are *really* different. For example, it is undesirable to base a classification system on a character which merely differentiates between two sexes of the same species or may only be the result of an extraordinarily cold winter or warm summer. Such ephemeral properties are "adaptive" within a species population, and, since their frequency within the population is variable over a long period of time, they are unsuitable as a basis for theories concerning the remote past.

But, after all, it *is* only their skeletal remains which our antique relatives willed to modern museums—perforce this is everything at the disposal of the anthropologist. Fortunately, these genealogists have reasoned, the skeleton is a relatively stable characteristic of a species—for if it weren't there would be no hope of tracing our ancestry. However, there seems to be not the slightest shred of evidence to justify the proposition that the skeleton is stable in an evolutionary sense. Useful as it may have been in the initial development of physical anthropology, the bone-by-bone classification scheme has rather serious drawbacks and may be destined to collapse finally of its own weight.

The resemblances which have been found between the bones of primitive human types and the modern human have usually been taken as an indication that modern man originated from these hominoids. But. critics have pointed out, such skeletal resemblances can be rationalized by other means. Some of these alternative explanations involve the whole question of racial mixing and evolutionary factors which vary over different parts of the world and which may even vary in time.

One of the most astonishing features of anthropology—revealing that there must be dangerous cracks in its edifice—is that it was capable of supporting the Piltdown man hoax—unwittingly of course—with sober researches and hypotheses. This hoax—perpetrated in 1908 by an English lawyer, Charles Dawson, who buried and then "discovered" a modern human skull which was interpreted for forty-five years as a quite remote ancestor of modern man—remains a blot on all of science to this day. Indeed anthropology was rescued—not by a new look at bone shapes and measurements—but only when is was found in 1953 that this masquerading skull contained no more fluorine than fresh bone and teeth.

Another instance—which is not an isolated example—of how little can be confidently ascertained if the criteria of comparative skull measurements are the only ones used, occurred during the 1936-1937 period. In 1936 A. E. Jenks described a skeleton from an excavation in Minnesota as deriving from the early glacial periods. Basing his judgment on craniometry Jenks found that his Minnesota skull was completely unlike that of any modern American Indian's. But in 1937 the noted anthropologist Ales Hrdlicka compared the measurements of the Minnesota skull with those of a group of forty Indian skulls of recent origin; he concluded that the "fossil" skull characteristics were those of a modern Sioux Indian and he offered the embarrassing suggestion that Jenks might have disturbed a very recent Sioux burial site. It is of small consequence who was actually correct (indeed this question is still argued). More important is the apparent fact that two highly qualified individuals differed so greatly in interpretation of the results of cranial measurements.

At this point, then, it is useful to consider some of the defects in the current classification scheme as these have been described by Boyd.

Bones and anthropometry. The underlying assumption of anthropometry is that any *individual* of one race should be distinguishable from any *individual* of another race. This is not in general true, especially when the differentiation has to be made solely on the basis of skeletal characteristics. Even William Howells, the Harvard anthropologist mentioned before, several years ago observed that, outside of being able to make a judicious guess, he could not always identify any single skull in order to differentiate it from any other in terms of race.

There have been frequent efforts to obtain racial differences and similarities from statistical studies of measurements on bones, especially on skulls. Such studies of likeness do not in general take into account the covariations of different

measurements of the same skull, and treat them as if they were statistically independent variables. The effect of this could be to cause very high or very low values of similarity coefficients to occur more frequently than they should by chance.

Another point is that the nature of skeletal features, like other characteristics of man, are determined by the action of many genes; therefore it is hard to establish whether a given morphological feature of one race is determined by the same combination of genes as an apparently identical feature in another race in another part of the world. As a result one could readily assume similarity of descent where it does not exist.

Another factor to arouse discontent with anthropometric methods is the observation that adaptation in response to environment may be relatively rapid where the bony parts are concerned, and further, that the form of the skull may depend somewhat on the muscle structures attached to it. The combined result is the creation of a broad distribution of skull features which may not be species or race-specific.

Obviously it cannot be argued that skeletal features are completely without use in classification procedures. What is emphasized is that the issue of man's origins and evolution cannot be resolved without a knowledge of the distribution and relative frequencies of variable genes and morphological features throughout a population.

THE STUDY OF PRESENT RACES

The ideal basis for human classification schemes is a group of properties for which the exact nature of the inheritance mechanism is understood. This is not the case for any of the morphological or metrical characteristics of the skeleton known at present. However, there is an alternative method of obtaining knowledge of the history of the human races, a means which does not concentrate on craniometry, but uses instead observations of the present distribution of human races and the genetic traits which have been employed to define them. One of the characteristics Boyd suggests as potentially fruitful for analyzing man's origins are the serological properties of the blood of present races.

Blood groups. Probably more is known about the distribution of the blood groups in various parts of the world than about any other human trait. Further, we know rather exactly the genetic mechanism by which the genes A., B, O, M and N, which are determinants of blood group, are inherited. The origin of the present human races could be clarified, Boyd suggests, if we were able to account for the origin of the differences in frequencies of the various blood group genes now observed.

It may be a reasonable assumption that earliest man started with O, A. and B blood types, since A-like, B-like and O-like factors are possessed by various anthropoids, e.g., gibbons, orangs, gorillas and chimpanzees. There are four ways by which the current geographical distribution of blood types could have been brought about: mutation, selection, genetic "drift" (in a small and isolated population a gene might disappear entirely by accident, without any relation to natural selection) and *mixture*. The last is an absorbing possibility, for if there has been mixing between species which had been different for a very long time, there is a strong presumption that the human race has a polyphyletic origin.

Up to now this genetic approach has been little more than a proposal accompanied by an embarrassingly small number of consequent insights and conclusions. One of the most apparent obstacles to any progress along these lines is the simple fact that there are few geneticists or biochemists professionally active in this area of research, compared with the much larger number of taxonomy-minded physical anthropologists still going over their chalky findings with calipers and tapes.

Polyphletic origin. Where Boyd argues that the origins of man may be in the union of orang-like, gorilla-like and chimpanzee-like ancestors, Dobzhansky opposes this notion. Dobzhansky's point is a strong one, for the orang, gorilla and chimpanzee, as they are known today, are without reservation seen as separate species, evidently completely isolated in that they are incapable of interbreeding. In view of this fact it is difficult to envision just how reproductively insulated populations could interbreed to the extent that all the diverse human races derived from this intermingling of gene pools exhibit no reproductive isolation whatever, i.e., all the races of man are capable of interbreeding.

On the other hand, Dobzhansky agrees to the possibility that several fossil hominoids are the ancestors of mankind. As a generalization he points out that there is no evidence now—or potentially available from comparative bone studies —from which one could assume that any one fossil type alone was capable of being transformed into man. Accordingly these fossil hominoids could have interbreeded so that the contribution of any one ancestral type to the general gene pool of hominoids was scattered before they became incorporated into modern racial groups. In this sense Dobzhansky can be said to be acquiescent to a polyphyletic theory of origins.

We know nothing about these hominoid populations that would entitle us to suppose that they were homogenous from any viewpoint whatever. Our ignorance on this score extends as well to all the fossil men we have raised from secretive eons of sedimentary repose. It seems entirely possible therefore that the human races have their origin in the interbreeding of various subspecies of early hominoids and that the long abandoned polyphletic theory deserves new consideration.—R. B.

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Genetics and human intelligence

Rockefeller University conference portrays a field promising much and delivering little — Session on population size reveals animals have self-regulation programs

by ROBERT BERNHARD, *Assistant Editor*

What is the heart but a spring, and the nerves but so many strings, and the joints but so many wheels . . .?
—Thomas Hobbes

In the belief that the furious brew of life is ultimately concealed in spirals of DNA, biologists have pried and poked at cells to recreate the molecular details of Creation. More recently, however, some men have turned their scrutinizing gaze upward and looked with new curiosity at the ineffable complexities of psychological and sociological behavior, seeking to extend the vision that all man's gestures and textures are secreted in the mosaics of his genes.

Rockefeller University—where the Second Conference on Genetics and Behavior met in chill November mist—is an unlikely strip of shrubbery, trees and quiet academic walks pressed against a Manhattan riverfront by mobbing avenues and hulking buildings.

In Caspary Auditorium, Orville Brim, president of the Russell Sage Foundation which, along with Rockefeller University and the Social Science Research Council, co-sponsored the Conference, greeted the small band of hierophants—genetic psychologists and behavioral biologists—with the portent that they were about to bear witness to a minor calamity: "Some bridges will be shaken here at this conference," Brim counseled gravely.

NATURE AND NURTURE OF INTELLIGENCE

Steven Vandenberg (Univ. of Louisville), a one-time lawyer and now one of the most notable among the psychologists studying the genetic background of human personality, led the gathering across its first bridge, "The Nature and Nurture of Intelligence". Although it may not have been his intention, Vandenberg's paper in recapitulation can be seen as a review of some of the essential and continuing frustrations of all behavioral science. At its ending the platform was left with a heavy pall of offsetting statements, examples and counter-examples, trailing Vandenberg uncertainly to his seat.

The genetic psychologist communicated the distressing information that, whichever study is cited as supporting a genetic determinant of intelligence one can point to serious experimental errors virtually invalidating the results; intelligence can be measured—but then again just what is intelligence? How do you measure what cannot be meaningfully described? The use of identical twins seems to be a satisfactory means of researching the effect of environmental variables on identical genotypes (genetic endowment of the individual) —but can we really distinguish different or equal environments? Finally there is the question of the relevance of statistical methods: here the splayed figures, jagged lines and skew curves of statistical graphology were indicated to have one or more elfin figures mocking the researcher from darkly abstract glens.

The Vandenberg debacle. Vandenberg began with a definition of "intelligence", from which it could only be concluded that behavioral science is still mired in the problem of meaningful definitions. First it was made clear that intelligence is not a unitary variable. Studies which use total IQ—in the Stanford-Binet sense—are bound to miscalculate the interaction between the individual's genotype and his environment in the development of personality traits. Human intelligence has many components, as little as the five defined by Vandenberg as independent factors — verbal comprehension, word fluency, number ability, spatial ability and reasoning—or as many as the 120 described by others.

Using similar measures of intelligence, different investigators obtain varying correlations with blood line, the largest consistency regularly occurring in studies of identical twins—which suggest correlations clustering around family groups —and in studies of adopted children—which suggest a better correlation between the child and its original father than with the foster father. But in virtually all cases there is no sufficiently high or consistent correlation to be able to clearly relate the intelligence spectrum of one child to another and to its parents'. Only where a task is "simpleminded", requiring only speed, is there an

emergent picture that genetic factors are the determinant factors. Even so, there is the ever-present question of individual motivation and social forces. Where motivation is lacking and social mores suppress aggressive and competitive behavior, the individual may express a regular pattern of low intelligence whereas these individuals may in fact have, for want of a better terminology, high "native" intelligence.

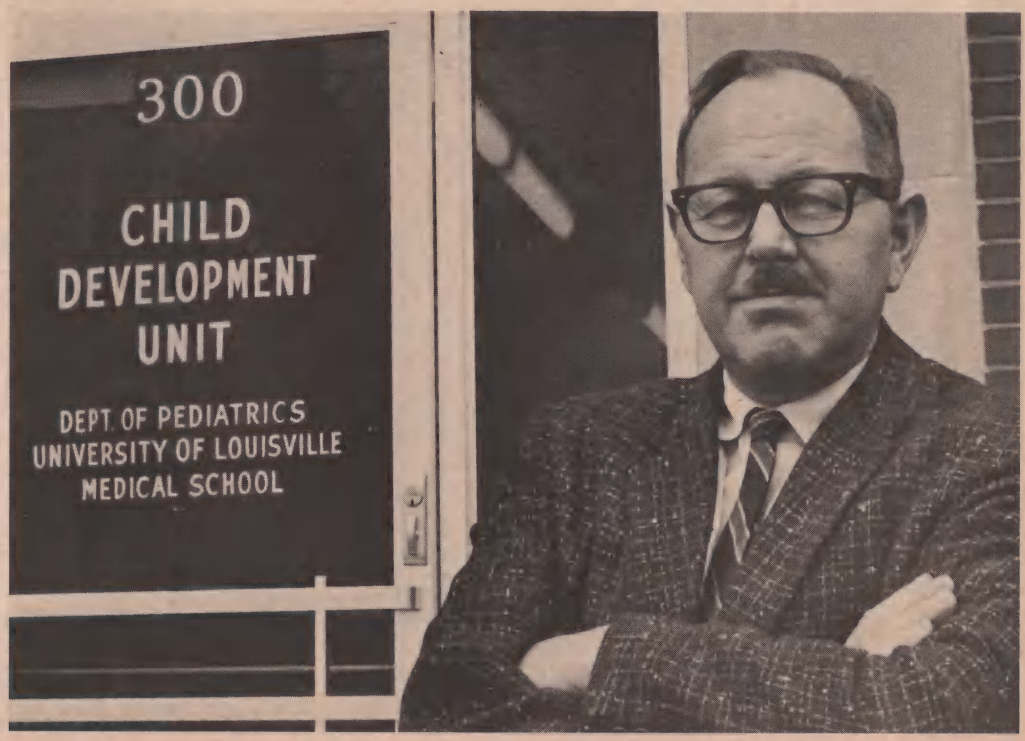
That this matter of motivation can affect whole populations is clear from research with American and Japanese school children. Typical results with American populations type boys as developing reading and verbal skills more slowly than girls. The converse results are obtained in the case of the Japanese population. Japanese boys, Vandenberg suggests, are on the whole more serious students than American boys. Japanese girls probably suppress competitive behavior—a distinctly different pattern from that shown by American girls.

Following the progress of identical twins probably provides the only large and reliable volume of evidence for genetic psychology; but, Vandenberg noted, there are certain distinctions in personality development between the populations of twins and single children which could invalidate the findings of all these investigations. Twins, for some still unexplained reason, seem to develop their language skills more slowly, and the sampled twin population usually demonstrates a narrow distribution of reading scores relative to sampled populations of singles. Therefore, whatever behavioral uniformities have been observed in twins —and interpreted as reflecting genetic uniformities—could be due to (a) approximately equivalent environments in which aggressive-competitive behavior is discouraged, and (b) genetic factors —not directly affecting intelligence—which produce more uniformity of constitution in the twin population than in the population of singles.

The end of Vandenberg's discussion came in a blaze of equivocation and abstraction. In attempting to correlate various components of intelligence between the individuals of a twin pair over long periods of time, Vandenberg developed a covariance matrix whose elements, C_{ij}, are the covariances between the intelligence components, $_i$ and $_j$ in each individual of the pair. From the determinant of the matrix the determinantal equation $IC_{ij}-\lambda C_{kj}=0$, known as the characteristic equation of the matrix, can be formulated. Here λ is the characteristic value of the matrix and may have multiple values, i.e., the characteristic equation may have many roots when solved for λ. Vandenberg proposed that the matrix characteristic may be a genetic operator acting to increase or decrease the differences between the individuals in question. In this case the number of roots of the characteristic equation yields the number of genetic factors acting within an individual.

In his own studies of twins Vandenberg always found four roots of this equation, within the limits of numerical computational error. However, he qualified, it is not clear whether all of the mathematics of this formulation are justified and, further, since the twins being followed frequently were separated throughout their schooling there is a serious question as to the identity of their environments—in which case λ no longer reflects solely genotypic effects.

Good research tool. It must be said that Van-



Genetic psychologist Steven Vandenberg, whose review on the "nature and nurture of intelligence" pointed to the essential and continuing frustrations of behavioral science. Whichever study is cited as supporting a genetic determinant of intelligence one can point to serious experimental errors virtually invalidating the results; intelligence can be measured—but then again just what is intelligence? How do you measure what cannot be meaningfully described? Can we really distinguish different environments? What is the relevance and reliability of statistical methods of study?

denberg's last proposition offers, in principle, a rather fascinating research tool for comparative studies. While the meaning of his equations is not entirely clear in this specific instance, nevertheless, as a generalization, the characteristic values of a matrix have a very provocative interpretation in this context: since any matrix is a transformation of coordinates from one coordinate system to another defined in a multi-dimensional space, the number of values of λ gives the *number of sub-spaces within this space which remain invariant under the prescribed coordinate transformation;* therefore the number of roots expresses the number of factors intrinsically responsible for a given effect and not a result of the particular frame of reference which has been chosen to describe the phenomenon. This, after all, is the basic aim of any theory of natural events —to find the *invariants* within a description of nature, those factors which are not merely linked to the specific language employed, but express relations intrinisic to any language which might have been used.

The holocaust. "Where is the human race headed?" Vandenberg asked in wistful farewell. At the same time a slide was flashed on the screen featuring some unidentified primitive men setting fire to a huge, shaggy mammoth who seemed to goggle with disbelief at the impudence of these ape-like tormentors. It was all too depressing, he concluded suddenly, and dividing his gloomy countenance between the horrific illustration behind him and the discomforted audience in front, he uttered sadly, "If it's always going to be like this, I don't know if it's worth it."

ROSENTHAL ON VANDENBERG

Sobering criticism. David Rosenthal, a research psychologist at the National Institute of Mental Health, had been selected to provide a critical discussion of Vandenberg's thesis. However, since Rosenthal, just as many in the audience, was able to catch only fleeting glimpses of this shadow-figure—the thesis in question—he found himself in an awkward situation. Like one who has begun his lunge at a menacing figure and at the last moment realized that the imagined danger was only some harmless prank of light and shadow, Rosenthal started with a stumbling gesture:

"Vandenberg has been less sanguine here, with respect to the role of genes in the determination of intelligence, than he has been in his publications," he complained, and then re-established balance by pointing out that he would have to continue wtih his pre-planned criticism.

First, Rosenthal submitted, we have no insight whatsoever into how psycho-neurosis affects all the components of intelligence mentioned by Vandenberg. In view of the widespread nature of psycho-neurotic symptoms, it is difficult to evaluate intelligence tests over a population in trying to make comparisons. In many ways it is like comparing apples and oranges for qualities they do not have in common.

Then the NIH psychologist posted the three items which, it seemed to him, indicated that genetic psychology has been dissappointing in its progress; that we know no more about the connection between genes and intelligence than was conjectured by the great physiological psychologist Woodworth, twenty five years ago.

- There has been a basic failure to eliminate the question of equality of environment and the entire field remains bogged down on this point.
- There is still no credible correlation between various components of the intelligence spectrum listed in all the family/children researches.
- While many experiments seem to conclude that there are convincing correlations proving a genetic determinant, there is such a wide range of difference in the test results of different investigators who conclude the same thing, that a serious doubt must be entertained.

David Rosenthal, research psychologist at NIH, criticized behavioral studies

In order to sharply focus the point that there is still no sound scheme for teasing out a genetic component from environmental factors, Rosenthal examined various sober studies which divide traits into the classes "high heritability" and "low heritability"—and composed a litany of some of their blatantly humorous results. "High heritability—" he began the intonation, "sang in a glee club; low heritability—took voice lessons. High heritability—rode roller coaster; low heritability —rode sports car." Here the audience laughed, Rosenthal paused, and then droned on solemnly; "High heritability—wanted to be a police judge; low heritability—wanted to be a judge. High heritability — took cough syrup; low heritability — took laxative . . ."

Proposes experiments. At the end of this service, which left his congregation more amused than penitent, Rosenthal adopted a constructive attitude. To separate out genetic and environmental factors he proposed parallel studies of *kibbutz* (communal settlements in Israel) life and *nuclear family life,* i.e., where the conventional family unit prevails as the major source of environmental stimuli. Further, he described, one could

study the effect of, say, how factors such as social introversion in parents affect children. A genetic factor determining intelligence would be suggested if one found that the intelligence of children was independent of the four possible types of parental pairs, highly introverted: highly introverted, highly introverted: little introverted, little introverted: highly introverted, and little: little.

The contribution of the genotype to schizophrenia, it was suggested, could be pinned down by investigating the children of schizophrenic parents, who have been given up for adoption. This population could be compared with the population of children of normal parents, who have been given up for adoption.

At this point one could not help feeling that, with these familiar propositions, Rosenthal was sending his colleagues into that same dark land from which—he had expended a great deal of effort, to show—no explorer has ever returned. Somehow, at the outset, having seized the ragged edge of a larger and crucial issue in this field, he had let it slip from his grasp: it will never be clear just what role is assumed by the genotype until it is known how individual motivation is developed in response to the personality of the parents and social patterns; Rosenthal had clung for a brief moment to one piece of this when he mentioned the role of ubiquitous psychoneurotic symptoms throughout society.

EFFECT OF POPULATION SIZE ON BEHAVIOR

In rising to introduce the major speaker, Aberdeen University naturalist V. C. Wynne-Edwards, session chairman and Nobel laureate Rene Dubos described how elephants in Africa "are having a difficult time since they are being hemmed in by highways and developments." On this account, he went on to say, there have been plans made for controlled executions which would reduce the elephant population and bring it into better relation with the available space and food supply. "But," he announced, "it seems that there may be no need to shoot them, for elephants have changed their breeding habits. There has been observed a three-fold increase in the interval between births." Somehow, through some store of instinctual wisdom, the elephant herd practices population control. "This," Dubos stated triumphantly, "could have been predicted by those who have studied population self-regulation in other verterbrates. In particular this could have been predicted by V. C. Wynne-Edwards."

Social homeostasis. Social competition has a significant influence on natural selection in confined populations of beatles, moths, crustacea, flies, fish, laboratory rats and birds. In all these creatures, Wynne-Edwards claimed, there are instinctual mechanisms acting to regulate mortality and recruitment, thereby controlling population density. While the available food supply is an important factor affecting population density, "it is the animal's *space* requirement," the naturalist emphasized, "that is uppermost; for it is the way in which the animals distribute themselves over a confined space—thus placing limits on total population—that ultimately regulates the demand for food." The result of this, he then pointed out, is that actually most animals may not submit to the classical Darwinian checks on population, e.g., competition with other species, for food, predators, etc.

A fascinating example of "social engineering" in animal communities can be seen in wolf and beaver populations. Wynne-Edwards described observations clearly showing that wolves in the islands of the Hebrides somehow regulate the killing of deer—never killing off more than a sixth of the deer population. It turns out that in these local deer populations one can experimentally exterminate a sixth of the deer herds *without destablising* this prey community. It is difficult to avoid the assumption that wolves engage in rather sophisticated administrative procedures quite analogous to those of human societies. In another such example it seems that the beaver in Scotland limits his tree-felling operations to approximately one-in-seven thousand trees—which allows precisely a necessary twenty year rotation period for the trees they consume!

The red grouse, which settle in great numbers over the vast Scottish moors, are large, noisy birds—easily flushed by dogs—whose main diet is heather. Heather comprises from 40-75% of the area's vegetation and is sufficient to support many more of these colorful game birds—yet, according to Wynne-Edwards, the red grouse population density rarely exceeds 50/km^2.

They regulate population concentration largely through "social selection", which leads to the expulsion of those birds which cannot win a territory for themselves. It is estimated that approximately 90% of the mortalities in the red grouse population is due to the enforced exile of socially "inferior" bird-citizens to a vagrant class. This vagrant class languishes on the periphery of the established community, succumbs rapidly to poor nutrition—the established groups always conquer the most nutritious vegetation, high in nitrogen and phosphorous—and, it is observed, they suffer seven times as many deaths due to predators than do the established birds. As the normal death toll creates territorial openings, the established society "recruits" replacements from the lingering citizens of the vagrant society.

In a final burst of fervor—perhaps the result of any naturalist's easy inclination to see human qualities in all the fauna making their way through a scientist's lonely vigils in bleak fields—Wynne-Edwards hypothesized that the same type of socially conventionalized competition has a selective influence on human populations, in a Darwinian sense. It is possible, he theorized, that the fight for social status reflects the central biological function of society, the preservation of the population by limiting all aggression and striving to

conventional forms.

Kessler's mice. Alexander Kessler, formerly a practicing physician, is now with the World Health Organization (Geneva). As a graduate student of animal behavior at Rockefeller University he began studying the extreme behavior of overcrowded mice colonies— about 800-1300 mice in 13 ft^2! As he unreeled a bill of behavioral distinctions between these oppressed rodents and the populations living in, by contrast, manorial splendor, in standard laboratory cages, parallels with the human misery caused by overpopulation emerged with depressing clarity. In the high density colonies:

- aggressive behavior increased;
- sexual and maternal aberrations increased, with a rise in the cannibalism rate;
- individuals behaved erratically—showing excessive reactions to slight provocations by neighbors, or showing no reaction at all to intense provocation;
- fetal death rate increased and newborn survival rate decreased drastically;
- twenty four hour physiological rhythms virtually dissappeared in the population;
- distinct physiological changes occurred, tending to reduce over all vitality and increasing vulnerability to disease.

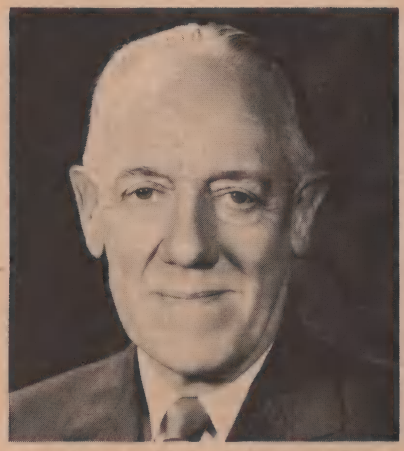
Flames of sentiment leaped and crackled as Kessler pitched in more kindling: after more than a year of their appalling existence, citizens of the overcrowded colony were given the opportunity of emigrating—via a door in their ghetto wall they could volunteer to resettle in a large, empty enclosure. What happened to these pioneers and escapees?

Among the emigres aberrant behavior increased relative to the "old world" community. There was more fighting, cannibalism, and disinclination to care for newborns among the colonizers—whereas these same manifestations of misbehavior were found to be on the decline in the thinning society left behind. A sharp distinction in the rate of population increase appeared early, the rate in the new colony rapidly surpassing that in the old.

Genetic studies—periodic census of genetic "markers" such as coat color pigment production —were designed to establish a possible pattern of genotypic differences labeling the various groups of mice. By Kessler's report, there were small but consistent biochemically discernible distinctions appearing in pigment production among the various colonies. Uninspiring as pigments might seem to those seeking clues that would pin genetic labels on certain behavioral traits, the fact of finding a persistent connection between them and social factors must be explained within the framework of Darwinian, natural selection mechanisms. It is banal to remark that social behavior, at least as much as predatory-prey and similar relationships, acts to selectively filter a particular strain through its sieves—indeed the fluctuations of Wynne-Edwards' red grouse population owe almost totally to social patterns. But it is better now to avoid contributing further to these unenlightening insights and unrewarding truths, for one wearies of experimental results which obstinately refuse conclusive interpretation or simply put the obvious in archival jargon. With Kessler's mice, as elsewhere, there is still no link forged between genetic makeup and personality traits.

Where laboratory mice are inflicted with the horrors of cancer research one may justify the inherent cruelties of experimentation with the romantic thought that these animals were tormented and sacrificed for tangibly useful ends. But here, where men have engineered so much and built so little—only a mysterious, questionable structure, whose aims and use are much in dispute —it is cause to wonder the worth of senselessly humiliating these laboratory creatures whose generations have stolidly borne the notion of self-sacrifice.

The New Behavioral Biologists



Detlev Bronk, Rockefeller University president, announces planning of new behavioral center

The recent acceleration in the United States of interest in the genetics of animal behavior is reflected at Rockefeller University, President Detlev Bronk told the Conference, where a social sciences research center will be established soon. One of the chief concerns of scholars in this planned center will be the study of feedback effects between the sociological and biological orders. Bronk noted that behavioral scientists at Rockefeller will have the use of a large animal laboratory which the University is assembling in cooperation with the New York Zoological Gardens.

Especially attracted to laboratories will be a new, polished version of a rather faded strain of biologist —the behavioral biologist. These new cosmopolites will arrive equipped with the profound credentials of modern biochemical genetics, the vigorous belief that the genes are the beginning and the end of all explanations of human behavior, and a wizardry for organizing projects and finances. The behavioral biologist of previous generations was weak in his biochemistry, unworldly in the ways of conforming all manner of events to the preconception that DNA is the master of men's thoughts and actions, and an eccentric recluse who spent most of his life spying on animals in lonely wilds.

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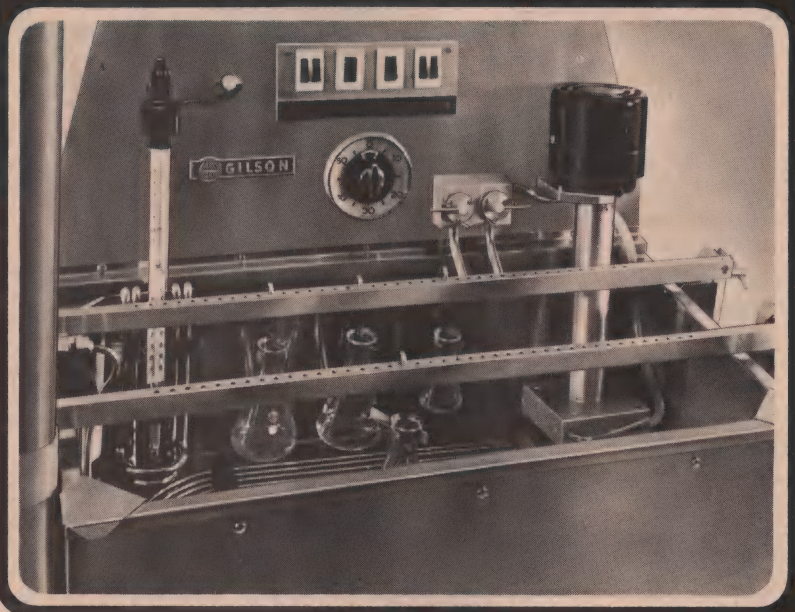

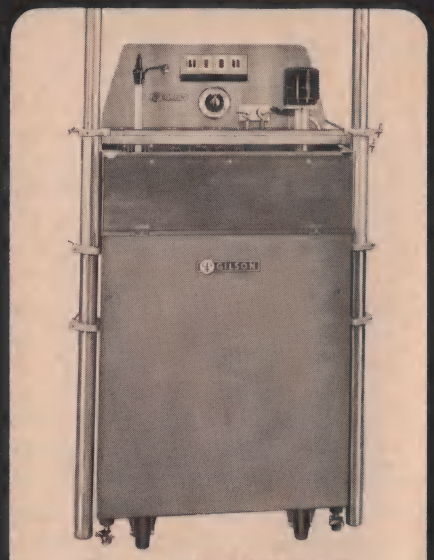

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René Dubos

'We are slaves to fashion in research!'

"Certain areas of scientific knowledge remain unexplored simply because they are not fashionable."

Fashions in science have historical and philosophical roots that reach into the whole social structure and affect so-called free basic research, as much as mission-oriented and applied research. Such fashions condition professional appointments and allocation of research facilities; they tend to starve out and eventually to discourage investigators whose interests differ from those of the majority. Let me briefly mention as examples two problems that are of fundamental and practical interest, yet are grossly neglected at the present time, even though they are amenable to scientific analysis.

Organismic biology has constituted the backbone of traditional medicine in the past, and has provided most of the prophylactic and therapeutic methods now available. However, organismic biology has fallen behind so-called molecular biology during recent decades because of the illusion that the detailed study of units at the lowest possible level of organization is sufficient to provide knowledge of the higher levels of organization.

Organismic biology is now deriving a new vitality from the pressure of a number of practical problems that require consideration of the whole organism's responses—for example the immunological problems of transplantation, the development of artificial organs, the training of men for operation in the arctic or the antarctic, in submarines or in space. It is being increasingly recognized, furthermore, that to understand man in health and in disease we need to consider both bodily and mental responses.

The phrase psychosomatic medicine incorporates this concept but is not very useful since almost anything that impinges on the body affects the mind and vice versa. Practically all important pathological disorders are psychosomatic, involving as they do both the body and the mind.

In practice, very little has been done to investigate the mechanisms of the interplay between body and mind. Many observations have been made pointing to the effect of mental stimuli on hormonal activities and biochemical processes, but

PROFESSOR DUBOS of The Rockefeller University in New York has long been renowned as a microbiologist and experimental pathologist. Recently his interest has focused on the biological effects of the total environment.

little systematic effort has been made to investigate this relationship despite its obvious relevance to many pathological states. Precise information is just strikingly limited with regard to the effect of physiological and metabolic reactions on mental processes.

The interplay between body and mind is one of the most grossly neglected fields of biomedical research, a negligence that is the more shocking in view of the fact that many concrete observations and well-developed techniques would make it possible and profitable to explore this area of biomedicine.

Environmental biology. The most spectacular advances in health during the past 100 years have come from improvements in the interplay between man and his environment. Better sanitation and nutrition, shorter working hours, less exposure to the inclemencies of the weather, and immunization against a few of the most destructive agents of disease are among the changes that have helped modern man to cope successfully with his environment.

"The interplay of the body and mind is one of the most grossly neglected fields of biomedical research . . ."

In contrast, our knowledge is incredibly primitive about the biological effects of the threats to health created by the new ways of life. Crowding, environmental pollution, indirect and delayed effects of drugs and food additives, constant exposure to a multiplicity of new physical and mental stimuli, alienation from natural biological rhythms, are but a few of the aspects of modern life which certainly affect the well being of man, and even probably the future of the human race. Yet environmental biology is an almost nonexistent scientific discipline; hardly any effort is being made to develop it, either in universities, research institutes, or medical schools.

The study of sickle-cell anemia has revealed that genetic changes occur rapidly under certain environmental conditions. One might therefore assume that genetic changes affecting response to crowding, and to other environmental stimuli, are likewise continuously going on in our communities. But there is no basis of theoretical knowledge to recognize these alterations, evaluate their significance, or guide man's attempts to govern his evolution.

Phenotypic changes can of course be observed more readily. Historical and present experience appears to suggest indeed that man can become adapted to almost anything—even to the most deplorable conditions. But in fact there are limits to the range of his adaptabilities. Knowledge of man's biological limits and thresholds is of extreme practical importance because it will determine the safe frontiers of technological changes. There is no doubt on the other hand that man has in reserve a number of potentialities which he could exploit if environmental conditions were favorable.

One of the most important determinants of environmental medicine is that development involves much more than the mechanical unfolding of potentialities according to the instructions of the genetic code. Biological and mental characteristics are influenced—often irreversibly—by environmental influences, especially those that impinge on the organism during its early formative phases. There cannot be any rational program of environmental improvement and especially of urban planning, until we learn more of the effects of early influences on the development of man's physical and mental characteristics.

In sum, adaptation to undesirable conditions is likely to be disastrous in the long run; failure to provide the proper conditions for the full development of human potentialities may lead mankind into blind alleys. The greatest task of biomedical science, and the most neglected, is to explore man's biological limitations and potentialities.

When W. B. Cannon borrowed the word serendipity from Horace Walpole, he used it merely to symbolize the fact that scientific investigators are likely to discover many interesting facts other than the ones they are looking for. Oddly enough, this simple concept has been given so much importance and dignity during the past few decades that it has become a dominant scientific philosophy. If one were to judge from much recent writing, even by some scientists, the justification for doing research on almost any subject is the statistical chance of achieving by accident useful and practical results. This cult of serendipity is based on an erroneous interpretation of the history of science, and furthermore amounts to an abdication of intellectual and ethical responsibility. Serendipity is the equivalent of Stephen Vincent Benet's line, "We don't know where we're going, but we're on our way."

"The cult of serendipity is based on an erroneous interpretation of the history of science . . ."

Finding and recognizing the value of things sought is of course part and parcel of the investigator's life. But granted this truism, it is nevertheless a fact that certain classes of phenomena are not likely to be discovered or understood, and some very important problems cannot be solved, unless attention is consciously directed to them. Hence the danger of letting whole areas of knowledge be as completely neglected as they are today. The mechanisms of body-mind relationships, the effects of crowding on physiological processes and

(*continued on page 54*)

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Cost ($)	7,995	13,500	19,000	n.d.	11,800 10,950	6,500	14,300	3,500–14,000
Dimensions (in. h × w × d)	35 × 29 × 27	36 × 47 × 29	69 × 51 × 14	49 × 33 × 30	Control console 20 × 20 × 16	19 × 31 × 23 (bench top)	59 × 39 × 34½	60 × 42 × 36
Sample changer								
sample capacity	100	200	408	100	150	100	150	50
manual controls?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
repetitive count, max. repeats before advancing	1 or ∞	Each sample counted 1, 2, 3 times or contin.	Auto. 1, manual ∞	1, 2, 3, ∞	2, 3, 4, 5, 6	n.d.	2, 3, 4, 5, 6	1
number of cycles selectable	One or continuous until stopped	1, 2, 3 or continuous	One or ∞	1, 2, 3, ∝	One	n. d.	One	Single or continuous
auto group counting?	Command tower	Yes	Yes	Yes	Yes	Yes	Yes	Yes
sample changing (sec)	<8	7	7	~40	13	10	13	12
temperature range (deg)	Ambient	Ambient	Room temperature to 30 C	0 C ~ +45 C	+10 F to +50 F	Ambient	+10 F to +50 F	5 C–room temp.
Detector								
shielding type, thickness (in.)	Lead, copper, 2	Lead, copper, 2	Lead, 2	Lead, cadmium, copper, 4	Lead, 2; steel ¾	Lead 2; steel, ¾	Lead 2; steel, ¾	Lead, 2½
type, photomultipliers	Two 12-stage Beckman/RCA	Two 12-stage Beckman/RCA	EMI 9514 S	EMI 6255	13-stage, quartz face	EMI 11-stage	13-stage, quartz face, S11 response	Single low noise
output	Logarithmic	Logarithmic	Linear	Logarithmic	Linear	Linear	Linear	Linear
pulse summation?	Yes	Yes	Yes	Yes	Linear adder	Linear adder	Linear adder	No
Analysis channels								
number	3	2 or 3	2	2	3	2	3	1–3
gain control	10-turn Helipot	10-turn Helipot	Coarse	Coarse and fine	Coarse and fine	Coarse and fine	Coarse and fine	Coarse and fine
channel selection	Fixed or variable	Fixed or variable	Variable	Fixed, variable	Variable	Variable	Variable	Independent, variable
Scalers								
number	1	3	2	4	3	1	3	1–3
range (no. counts)	1,000,000 cpm	1,000,000 cpm	10^6	999,999	999,999	1,000,000	999,999	10^6
preset count, each scaler	12 settings, ±15%–±0.2%	13 settings, 100–1,000,000	10–10^6 in steps of 10	1K, (−800K)	11, 100–1,000,000	11, 100–1,000,000	11, 100–999,999	10^3, 10^4, 10^5, 10^6 × 0.2, 0.4, 1.
background subtraction, each channel?	Yes	Yes	No	Yes	Yes	No	Yes	No
Timer								
range	0–100 min	0–100 min	1/1000 min–1000 min.	99.999 min	99.99 min	0—99.99 min	99.99 min., 999.9 min.	10^5 sec
increments	Hundredths	Hundredths	1/1000 min	0.001 min	0.01 min	0.01 min	0.01 min, 0.1 min	1 sec
timer accuracy	Function of line frequency	Function of line frequency	Quartz stabilized	±0.1%	+0-1 least significant digit	±0.005 min	±0.01%	±0.01%
preset time selection	1-2-5 steps from 0.1 to 500 min	10 settings, 0.1–100 min	1/100 min	0.1, 0.2, 0.4, 1, 2, 4, 10, 20. 40, 80	13, 0.1 min–100 min	11, 0.1 min–99.99 min	13, 0.1– 999.9 min	10, 10^2, 10^3, 10^4, 10^5 × 0.2, 0.4, 1
Display								
type and control	Ratemeter and printing register	Projection, push-button selection	Numeric, 18 tubes	Numerical time A, B scaler switch sel.	Nixie tube; pre-time, precount	Neon decades, pretime, precount	Nixie tube; pre-time, precount	Digital indicator
sample?	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
time?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
gross counts/channel?	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
cpm?	Yes	Yes	No	No	No	No	Manual op. only	No
% standard deviation?	Yes	Yes	No	No	No	No	No	No
other	Channel, sample position	Channel, manual automatic sample	—	—	—	Stored display	—	—
max. count capacity	10^6	10^6	10^6	999,999	999,999	10^6	999,999	10^6
Automatic standardization								
isotope(s)	Cs-137	Cs-137	Double- and triple-coincidence	Cs-137	Ra-226	—	6860; Ba-133; 6863; Ra-226	None
type, controls	Auto manual extern. std. ratio	Auto manual extern. std. ratio	—	Motor	On-off	—	On-off	—
shielding between counting chamber, ext. std.	Lead, 4-in.	Lead, 4-in.	No external, internal standard used	Lead, >4-in.	Lead, tungsten, n.d.	—	Lead, tungsten, nd.	—
Data presentation								
printout devices	Sedeco printer	Teletypewriter	Digital printer	Tape lister	Printer	Built-in printer, ratemeter output	Typewriter, printer, teletypewriter	Tape printer, tap punch, typewrite
Min. performance								
tritium E^2/B	100	100	50	60	120	40	120	35
carbon^{14} E^2/B	300	300	250	250	340	200	340	200
carbon^{14} efficiency, 1% H^3 efficiency	70%	70%	70%	70%	75%	75%	75%	75%
carbon^{14} at 30% H^3	4%	4%	10%	7%	7%	10%	7%	20%

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NE 8310	2000 Series	3000 Series	4000 Series	650–503	652–800	CM-25/SC-535 AL	CM-100/SC-535 AL	Beta/Matic-40
16,000	6,250–10,950	12,500–16,750	17,500–20,500	14,000	13,250	6,250	6,500	14,250
60 × 48 × 36	65⅛ × 23 × 30½	61⅜–67⅜ × 42 × 30¾	75½ × 35¼ × 34¾	67⅞ × 38 × 34 1/16	56 × 41 × 33⅜	21½ × 23 × 17	21¾ × 27½ × 19	57⅛ × 53⅜ × 33½
400–1,000	100	200	360	200	200	25	100	200
No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1	1 or ∞	1 — 10 or ∞	Selectable 1 — 10 or ∞	1 only	1, 2, 3 or infinite counts	1 — 7 or ∞ if spec.	1 — 7, or ∞ if spec.	1 or ∞
Single or continuous	∞	1 — 10 or ∞	Selectable 1 — 10 or ∞	1, 2, 3 or infinite cycles	Continuous only	1 or ∞	1 or ∞	1 or ∞
Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes
5	3	3	3	<3	~3	11	11	<20
Ambient	Ambient	−5 C to +15 C within ±0.5 C	−5 C to +15 C within ±0.5 C	−15 to +25 C	−5 to +20 C	Ambient	Ambient	~4 C
Lead, 3	Graded cadmium, copper, lead, 2	Graded cadmium, copper, lead, 2	Graded cadmium, copper, lead, 2	Graded iron-copper and lead; 3½	Lead with copper; 2.4	Lead, 2	Lead, 2	Stainless steel and lead, 2
High gain, high sensitivity	13-stage	13-stage, quartz-face	13-stage, quartz-face	EMI 6255B	EMI D-205	RCA low noise	RCA low noise	EMI 13 dynode-quartz faced
Logarithmic	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear
Yes	Linear	Linear	Linear	Yes	Yes	Yes	Yes	Yes
3 + 2 for ext. standardization	2 or 3	5	5	3 (2 or 1 optional)	3 (2 or 1 optional)	1, 2, or 3	1, 2, or 3	3
Fine	Range, coarse, fine	Range, coarse, fine	Range, coarse, fine	None	None	Coarse and fine	Coarse and fine	Coarse and fine
Fixed, variable	Separate variable channels	Separate variable, six presettings	Separate variable, six presettings	Variable, 2 discriminators/channel	Variable, 2 discriminators/channel	Variable	Variable	Variable
3 + 2	1, 2 or 3	3	3	3 (2 or 1 optional)	3 (2 or 1 optional)	1, 2 or 3	1, 2 or 3	3
10^6	999,999/channel	999,999/channel	999,999/channel	999,999	999,999	999,999	999,999	999,999
10^3, 10^4, 10^5, $10^6 \times$ 0.3, 0.6, 1	10 settings, 1,000–900,000	13 settings, 100–900,000	13 settings, 100–900,000	Channel B, 200–200,000	10^3 to 10^6	16 settings (5–500,000)	16 settings (5–500,000)	16 positions (5–500,000)
Yes	Yes	Yes	Yes	Yes	Yes	Yes (if spec.)	Yes (if spec.)	No
10^5 sec real or live	200 min	0.001 min–500 min	0.001 min–500 min	99.99 min	99.99 min or 999.9 sec	999.99 min or 999.9 sec	999.99 min or 999.9 sec	999.99 min or 999.9 sec
1 sec	0.01 min	0.001 min	0.001 min	0.01 min	0.01 min or 0.1 sec	0.01 min or 0.1 sec	0.01 min or 0.01 sec	0.01 min or 0.1 sec
0.01 %	+0, −0.01 min line frequency cont.	+0, −0.001 min crystal controlled	+0, −0.001 min crystal controlled	±0.02 %	±0.001 min or ±0.01 sec	0.01 %	0.01 %	0.01 %
10, 10^2, 10^3, 10^4.	12 settings: 0.1 min–100 min	12 settings, 0.1 min–500 min	12 settings, 0.1 min–500 min	7 steps; 1–100 min	7 steps; 1–100 min or 10–1,000 sec	11 settings (0.2–500 min or sec)	11 settings (0.2–500 min or sec)	11 settings (0.2–500 min or sec)
$10^6 \times$ 0.3, 0.6, 1								
Digital indicators, switched	6 Nixie tubes, selector switch	7 Nixie tubes, push-button	7 Nixie tubes, push-button	6 digits segmented, pushbutton	8 digits, projection 4 position selector	Numeric, 6 in line, manual, auto	Numeric, 6 in line, manual, auto	Numeric, 6 in line manual, auto
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yes	No	Yes, net cpm each channel		Yes (at end of count)		No	No	No
Yes	No	Yes	Yes	No	No	No	No	No
—	—	External stand. ratio	External stand. ratio	Net counts, each channel: extern. stand.	Net counts, each channel; extern. stand.	Auto sequential display sample no. count, time	Auto sequential display sample no. count, time	Auto sequential display sample no. count, time
0^6	999,999	999,999	999,999	999,999	999,999	999,999	999,999	999,999
Cs-137	Ra-226	Ra-226 and Americium-241	Ra-226 and Americium-241	Cs-137	Cs-137	Ra-226	Ra-226	Cs-137
Auto. or manual	Manual in-out, auto, net count	Manual in-out; auto net count	Manual in-out, auto net count	On-off switch; window adjustment	On-off switch; window adjustment	Manual	Manual	Auto
Lead, 6-in.	Lead, 12-in.	Lead, 12-in.	Lead, 12-in.	Lead, 4-in.	Equivalent 5-in. lead	Unnecessary external source	Unnecessary external source	n.d., min. 4 in.
Typewriter, printer, punch	Digital printer	IBM Selectric typewriter	IBM Selectric typewriter	Lister	Lister	Printer, teletype-writer	Printer, teletype-writer	Printer, teletype-writer, calculator
90	100	140	140	<100	<100	70	70	100
250	300	350	350	<300	<270	280	280	400
60 %	70 %	75 %	75 %	75 %	75 %	63 %	63 %	60 %
25 %	7 %	5 %	5 %	7.5 %	7.5 %	10 %	10 %	10 %

Waltham, Mass. nd.=no data supplied.

Accessories available: These may include multichannel analyzers, gamma counting equipment, chemicals, continuous flow cell adaptors, ratemeters, plug-in modules, data presentation equipment, and others.

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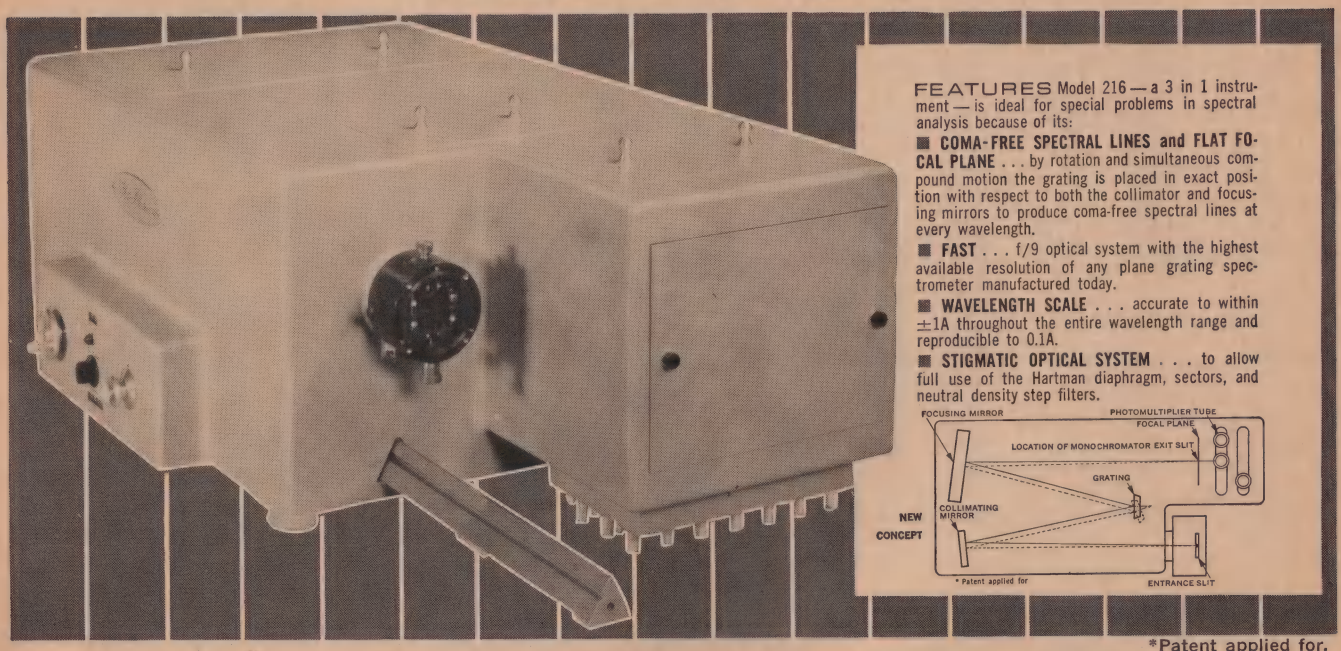

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Molecular biology: caricature of truth?

MOLECULES AND EVOLUTION by **Thomas H. Jukes** (Columbia University Press, New York, 1966, $10, 282 pages)

Reviewed by **Robert Bernhard**

Somehow, in the primeval bogs with their riot of molecules, the first feeble warmth of life was concealed in the chemistry of carbon.

From these sloughs began the troubled ascent to the talking, yearning animal who now looks with wonder and curiosity at the trail of life which leads back to his origins.

With the rise of modern molecular biology men have probed defiant protoplasm in an effort to wrench from its jelly of molecules the secrets of our beginnings and the inscrutable modifications, known as evolution. We know that somehow there is a pattern, somewhere in all the museums of bones and beakers of shredded molecules the improbable varieties of life blend to a single phantom figure.

The current passion is to identify that shadow with the spiraling genes of the DNA molecule, so with ingenuity a generation of biochemists grapples with this slippery presence popularly regarded as the "master chemical" of the living cell. The notion that it is this blob of genes whose biochemical emanations are the fundamental threads of biological process and evolution is the central dogma of Jukes's remarkable compendium of facts and speculations on the translation of gene mutations into changes in cellular proteins. Proteins are the most versatile class of biomolecules, and their hundreds of different types—each specified by a gene or combination of genes—specifically catalyze all biochemical reactions, presumably excercising immediate control over all function in living organisms.

But precious as this work should prove to be for all students and researchers in biology and biochemistry, something mocks us with an elfin mischievousness through its pages. All the glibness that Jukes uses to assure us that we have at last tracked the secret of life to its last concealment cannot erase the glimpse all of us have got of an elusive, insolent suggestion: inheritance depends on the kinetic structure of multimolecular interactions, and therefore biochemical regulation of life cannot be the property of any single substance or particle, but *the property of the whole intact system.*

The broadside challenge lately hurled by Commoner at the "DNA-dogma" (SR, Oct. '66, 33) is only a recent manifestation of a discontent felt in some laboratories for a very long time. Whereas Commoner bases his attack on recent evidence that DNA may not be self-duplicating after all and that there is specific genetic information (dictating the nucleotide sequences [genes] in DNA) in the synthetase enzyme which catalyzes the synthesis of new DNA, it is a fact that more than 20 years of work by Sonneborn, Beadle, Nanney, Darlington and Sager has produced irrefutable evidence of the existence of heritable features which are independent of the genetic control of nuclear DNA.

Sonneborn's classic studies of self-replicating pre-formed cell structures, for example, the gullet apparatus in *Paramecium aurelia,* and Darlington's work with "cytoplasmic inheritance" in plants, chickens and mice, still sends a number of adventuresome rebels out yearly to try and confirm the hint that mitochondria and chloroplasts — sites of cellular respiration in animal and plant cells respectively— are self-duplicating structures independent of nuclear DNA.

FINAL DISILLUSIONMENT?

While these and other considerations to be noted below do not detract from the extraordinary value of this book—the intellectual feat of integrating the whole breadth of our knowledge of molecular genetics with the principles of classical biology—they point however to a final disillusionment for the "objective" reader. This reader, who is neither a zealot of the DNA religion nor radically discontented with it, simply will not find in all this wealth of facts and logic anything like a provocative unified model which might relate the genetic code and evolution of the *dynamic* organization of cell function, differentiation and morphology.

What is worse, the author, like most classical experimentalists, seems unaware that such unifying models indeed exist — chemical kinetic models rigorously defined and worked through by mathematical analysis. But the majority of working biochemists prefer the vexations of recalcitrant laboratory equipment to those of mathematics and thermodynamics.

For the reviewer's part the most exciting of these kinetic models is due to Kacser (Univ. of Edinburgh), a close associate of the famed geneticist Waddington. This is a propitious time to look at unconventional views because all of us seem to have reached a certain plateau of banal insight at this moment of history. For the enormous success of the customary types of genetic experiments have in a way diverted the search from other areas and due to its very methodology modern molecular biology makes it unlikely to elucidate broad areas to which other principles apply.

Our present desire to see the genes as the pre-eminent controllers of the phenotype must be modified when the complex chemical reaction structure in which they are embedded is taken into consideration. In such a complex of interacting chemical networks many properties arise which cannot be assigned to any single isolable entity. It is only when an analysis is made of these dynamic processes that relations are revealed which are truly what we call "biological" —and it was such an analysis which Kacser used as a departure point.

To begin with, the most important characteristic of the cell is that it is an *open* system of catalyzed chemical reactions, i.e., there is a net flux of molecules across its boundaries in both directions. An important property of such a system is that it may reach a state when certain of its components have

(*continued on page 42*)

Robert Bernhard, Assistant Editor of SCIENTIFIC RESEARCH, previously worked in research in mathematical biophysics of cellular control processes at MIT and Grumman Aircraft.

(*continued from page 41*)

time-invariant values—*steady-state* values—accompanied by other components having constant or exponential rates of change. Since all enzymes essentially affect reaction rate constants in the cell, Kacser's model consists of a mathematical analysis to find (a) how the nature and quantity of enzymes affects molecular fluxes, (b) in what way these fluxes will be reflected in growth properties, and (c) how different relations between reaction steps determines the time-evolution of the system.

For example, the equations show that steady-state values are independent of starting quantities of the system components. This means that any displacements will be rectified by a re-establishment of the steady-state values so that in ontogeny—reflected by the transient changes as the system progresses towards a stationary condition—a disturbance will be buffered out and the system will wind up with the same composition.

Clearly this property of living organisms, known as equifinality, is an automatic result of the nature of the open system. Similar properties of self-adjustment and regulation exhibited by such networks are the typical nature of open, multi-enzyme systems and were not obtained through such intricate mechanisms as are envisaged in the term "natural selection."

SIGNIFICANT FEATURE

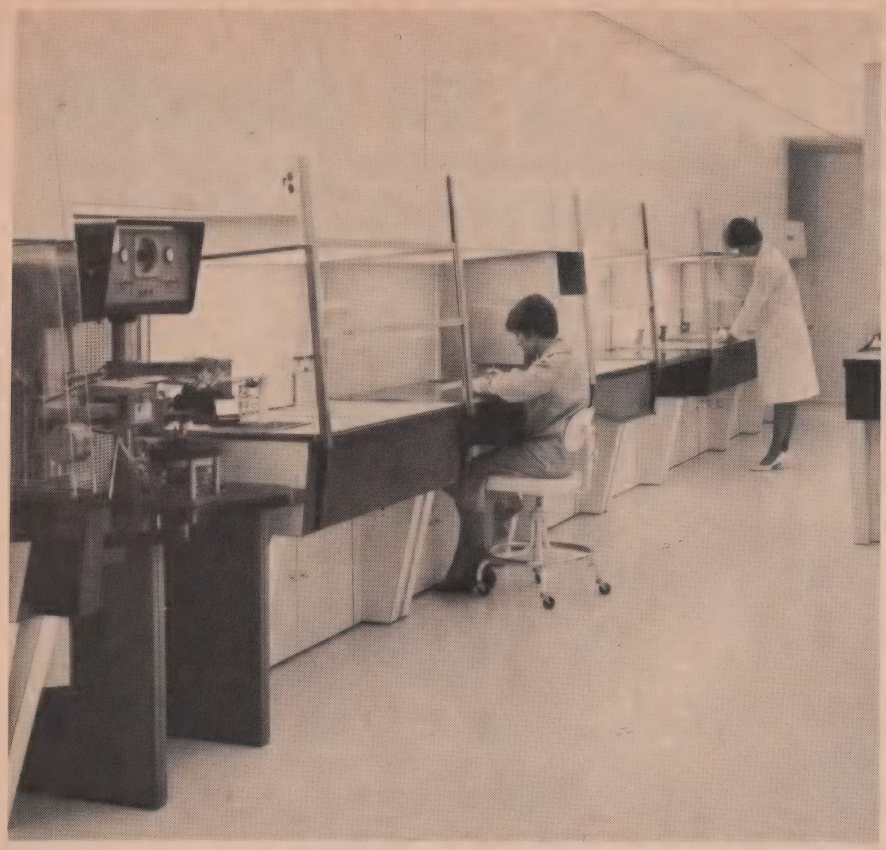
A very significant feature of the analysis indicates that some enzymes seem to have no effect on the flux of molecules though specific reaction sequences, while others clearly have. That is, some enzymes act simply as *buffering* mechanisms. This characteristic of a multi-enzyme network suggests re-evaluation of the current understanding of just how far gene-control of cell structure and function really extends. Because genetic mutations—which cause alterations of enzyme activity—in a given instance might not exert any effect at all on the phenotype, it is clear that the kinetic interactions within the cell itself constitutes a hereditary system. The work of Sonneborn, Darlington, Nanney and Beadle, who have argued so long for the role of preformed cell structure in heredity, takes on a new and broader significance in the light of this kinetic model. Insofar as genetic and evolutionary factors influence the phenotype, the current scheme of genetic control must be modified by considerations of redundancy due to interactions. This matter of the influence of structural, non-genic factors on heredity is worth further laboring.

Kacser examined non-genic conditions of an *historical* nature which could determine the metabolic properties of a cell; that is, instances in which prior biochemical states of the system may determine its future course. In such circumstances one would have heritable properties which are not located in the genetic apparatus as we know it. By looking at the example of an inducible transport enzyme, a *permease*, one is able to show that *two organisms genetically identical can co-exist in the same external environment but have different metabolic properties because of differences in historical development.*

From the solutions of a kinetic system in which the rate of production of permease is autocatalytic there emerges the features of an "on-off" switching system. The introduction of permease to the uninduced system does not result in induction but in the vanishing of permease concentration in the steady state. Conversely when inducer is added there is a point at which the zero solution of the kinetic equation for permease concentration becomes unstable and "switches" to a steady state production of the enzyme. In other words the enzyme induction system alternates from one metabolic path to another by the addition of certain quantities to the non-functioning path.

These alternative states of the preformed switching structure are heritable so long as the *boundary conditions*—which pathway is functioning at the time of cell reproduction—are unaltered. The kinetic state of an organism can be as much specified by the pre-existence of certain boundary conditions as by the enzymatic consequences of gene activity.

But in all these generalities on the features and future of modern molecular genetics we have paid too little praise to Professor Jukes. His book abounds with inspirational messages for that army of students seeking a doctoral thesis topic. As an encyclopedic reference manual this volume should become a fixture of every laboratory.



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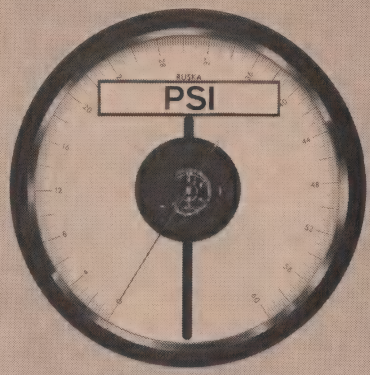
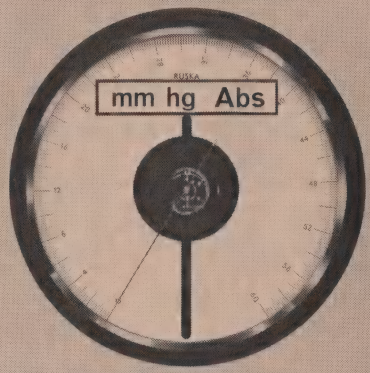
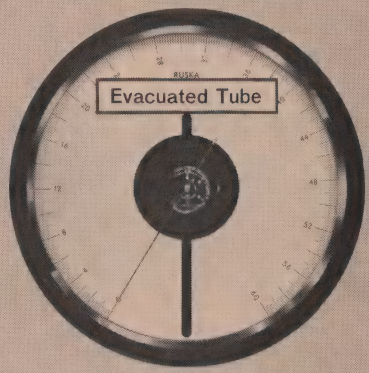


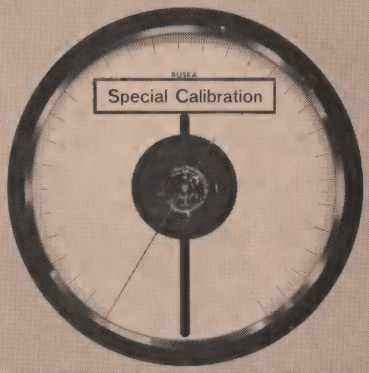
NO HYSTERESIS



ABSOLUTE PRESSURE



0.03% ACCURACY



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8", 12", & 14" diameter dials.
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Circle 22 on READER SERVICE CARD

New "tabletop" cyclotron makes appearance in U.S.

The newest addition to a line of compact "tabletop" cyclotrons has just appeared on the European market, with availability in the U.S. Made by Philips of Holland it is, with the U.S. Cyclotron Corp. machine (SR, April '66, 40), one of a new generation that will open up new areas of research to the smaller, less well-endowed laboratories, hospitals and universities because of low initial and operational costs and compact size.

The Philips machine base price is $160,000-$200,000 (the Cyclotron Corp. machine starts at $240,000). Weighing 10 metric tons, the Phillips cyclotron magnet measures 6 ft x 3.5 ft x 2.5 ft, with a pole diameter of 28-in. With these measurements it can fit into a large-sized laboratory room without the need for a new building. A conventional-size cyclotron can cost up to ten times as much and require three or four times the room.

Philips have set up something like an assembly line for production of their new cyclotron, although they will only be built to order. However, they will follow a standard pattern, with variations for customer specification. Delivery in this country will be 12-18 months, according to a company spokesman.

The cyclotron is offered in three models. Model A is a fixed-energy 20-Mev He^3 accelerator. Model B is a fixed-energy machine capable of accelerating protons to 12 Mev, deutrons to 7.5 Mev, He^3 to 20 Mev and alpha particles to 15 Mev. Model C is a variable-energy He^3 accelerator with a range of 8-20 Mev.

In medicine the accelerator will produce short-lived isotopes such as oxygen-15, nitrogen-13 and carbon-11 for pulmonary physiology and blood flow studies as well as other diagnostic studies where the phenomena under study is very rapid. These isotopes have half-lives as short as two to 20 minutes and must therefore be produced by a cyclotron at the place where they are used. In addition, there are several neutron-deficient nuclides and positron emitters that are of great interest to nuclear medicine and can only be produced in cyclotrons.

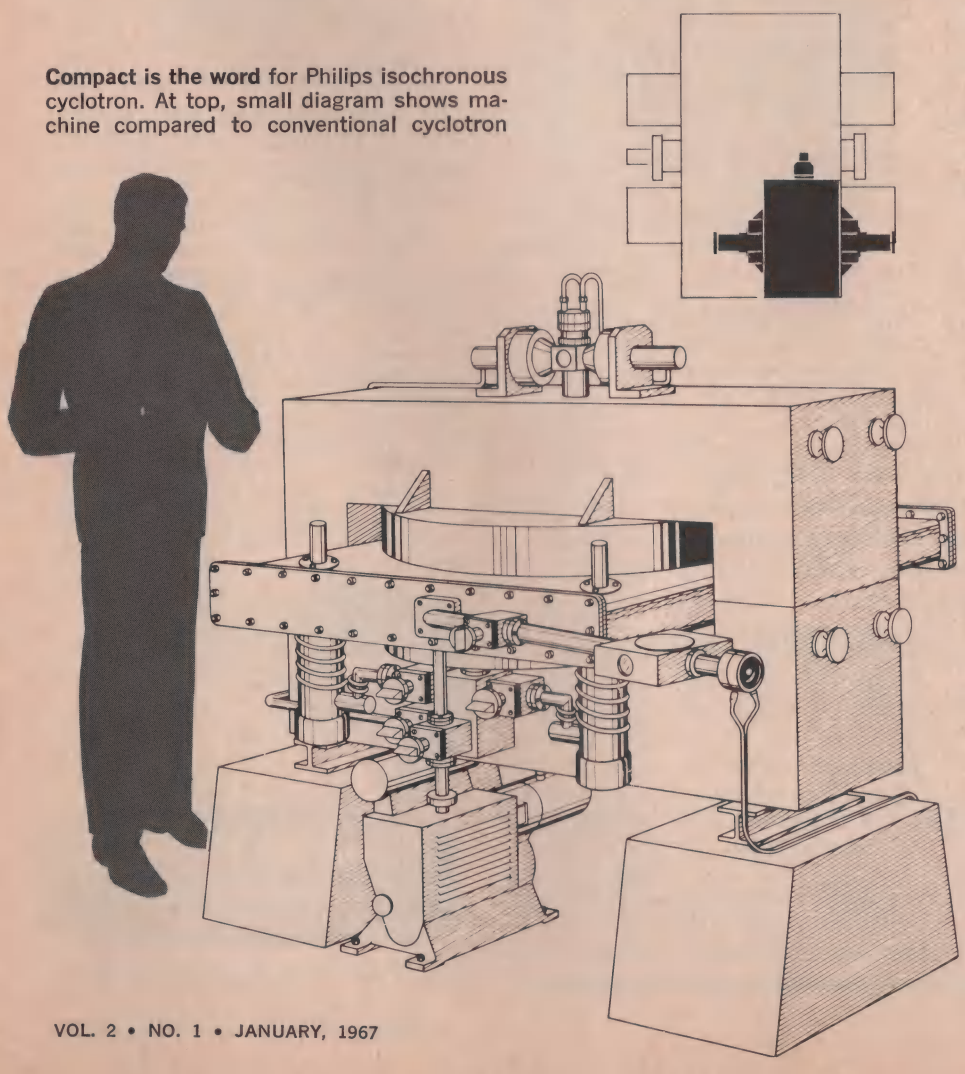
Use of the variable-energy He^3 beam is important for neutron activation analysis. By varying the accelerating potential and the target isotopes one can obtain approximately monoenergetic neutrons with the energy one wants for reaction. For each sample the neutron energy can be chosen to minimize or eliminate interferences, and resonance absorptions can be used to maximize the desired activity. The Philips machine has a neutron flux of better than 10^{12} neutrons/sec from the 100 microamp He^3 beam, using a suitable target which will let one analyze in the parts-per-billion range.

In educational uses the compact cyclotron can be an economical machine for demonstrating nuclear reactions. Power requirements, running costs and maintenance are low.

The He^3 particle is characterized by a favorable combination of low binding energy and high Z^2/m ratio. The former ensures that a nuclear reaction is initiated at a low energy level, while the latter means that particles with reasonably high energy can be produced in the small cyclotron. Energy resolution is 1%. Vertical beam quality is 300 milliradians and radial beam quality is 150 milliradians. Power requirement is 100 kilowatts. —Philips.

Circle 160 on Reader Service Card

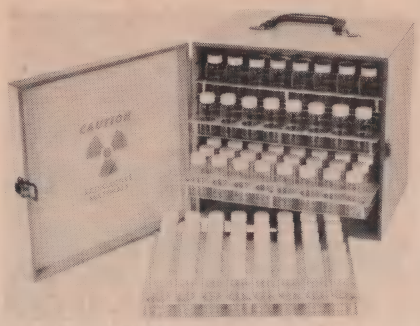
(*continued*)



Compact is the word for Philips isochronous cyclotron. At top, small diagram shows machine compared to conventional cyclotron

NEW PRODUCTS

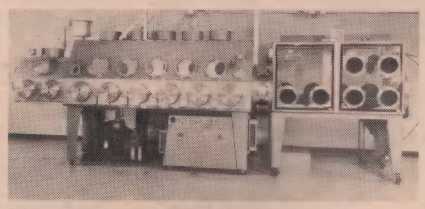
(Continued from page 45)



ISOTOPE STORAGE

This line of radioisotope storage cabinets will house sources, standards and sample preparation materials. The cabinets have a variety of trays which can accommodate several sizes of planchets, scintillation vials and sources. Made of laminated wood, the cabinets have a formica outside surface. An additional feature is a security lock and a top carrying handle.—Nuclear Associates Inc.

Circle 129 on Reader Service Card



PLUTONIUM PROCESSOR

Custom Model HE-433-31/HE-113-66 combination vacuum chamber/ambient pressure dry box is intended for nuclear fuels research and production. Features include a 36-in.-long transfer lock on the left side of a 120-in. by 42-in. vacuum chamber. The back of the vacuum chamber has the same number of working stations as the front. The chamber is connected to the dry box by a detachable transfer tunnel which can be sealed at both ends. —Vacuum/Atmospheres Corp.

Circle 128 on Reader Service Card

PERMEATION CHROMATOGRAPH

Model 200 GEL Permeation Chromatograph permits rapid determinations of the molecular size distribution of polymers and features a Speedomax W recorder. The separation method involves column chromatography in which the stationary phase is a heteroporous, solvent-swollen polymer network (usually a polystyrene gel) varying in permeability over many orders of magnitude. Column effluent

passes through sample and reference cells of a differential refractometer. Samples pass through a syphon, interrupting a light beam and transmitting a pulse to the recorder chart. In this way each 5-ml fraction is continuously itemized.—Waters Associates, Leeds & Northrup Co.

Circle 135 on Reader Service Card

PORTABLE SCALER/TIMER

Model SA-262 is a portable transistorized scaler/timer for versatile field or laboratory use. Rechargeable nickel-cadmium battery gives six hours' continuous operation, and the 22-lb instrument can also be used directly on a-c current. The fork-tuning mode timer can be preset on ½-min increments from 0.5 min to 4.5 min. The timing off switch also allows continuous counting over longer periods of time. GM, scintillation probes, Bf_3 tubes and proportional counters can be directly connected to the scaler.—Nuclear Supplies Inc.

Circle 127 on Reader Service Card

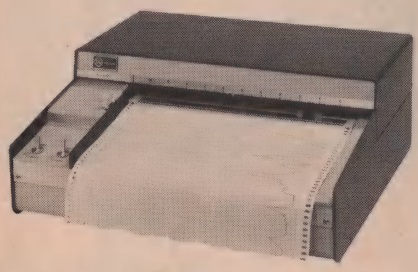


CHART RECORDER

Series G-2000 10-in. strip chart recorders is designed for use with laboratory and process control in-

(continued)

(Continued from page 47)

strumentation. Bench-top styling is featured in single and dual channel models, and special versions include filter networks required for optimum performance in gas chromatography, spectrometry, radiation detection, etc. Sensitivity is 0.1% of the 10-in. span, accuracy is 0.25% or better and pen response 0.5 sec full scale.—Varian Associates.

Circle 136 on Reader Service Card

WORK VIEWER

The StereoRama work viewer on a panoramic arm is a magnification tool that provides a viewing area of more than 40 sq in., with ample working distance between lens and material for free use with hands of probe or other instrument. Because of extreme depth of field the lens requires no focusing. Instruments are oriented to work instantly and work may be moved through all focal points. — EdnaLite Research Corp.

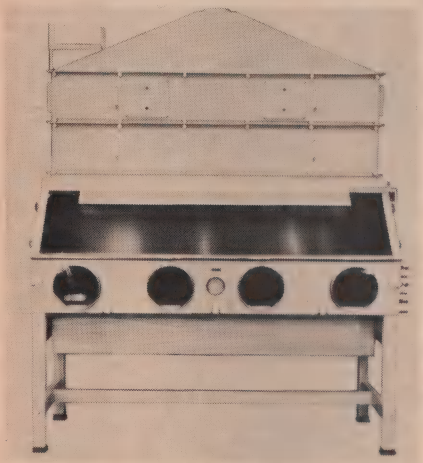
Circle 130 on Reader Service Card

TEMPERATURE PROGRAMMER

This all solid state linear temperature programmer, designated Model TP-1000 regulates from 0° to 1,000° C without cycling or over-

shoot. Automatic advance of control point is variable between 2° and 60° C/min. Signal from the platinum resistance sensor is fed to a solid state amplifier which is adjustable for sensitivity. Up to 10 kilowatts of power is proportionally applied via silicon-controlled rectifiers.—T & T Controls Co.

Circle 139 on Reader Service Card



SAFETY CHAMBER

Model BG-66 is a biological safety chamber designed for safe handling of biological agents and bacteriological specimens in a controlled atmosphere. The chamber is equipped with outlets for all utilities and vacuum, plus a decontamination solution source. It is supplied with stainless steel sink, 100-watt fluorescent lamp for interior illumination and three ultraviolet lamps for chamber decontamination. — Harford Metal Products Inc.

Circle 138 on Reader Service Card

MAGNESIA-SILICA GEL

FLORISIL 60/100 PR magnesia-silica gel is intended to produce a selective adsorbant of consistent behavior for use in column clean-up and separation of chlorinated pesticide residues prior to identification and measurement of the pesticides by gas, thin layer or paper chromatography. — Floridin Co.

Circle 137 on Reader Service Card

GLASS DOORS

Forming a good seal against dust and air currents, the RijiClad sliding glass doors improve convenience and safety in storing and dispensing sterilized glassware and uten-

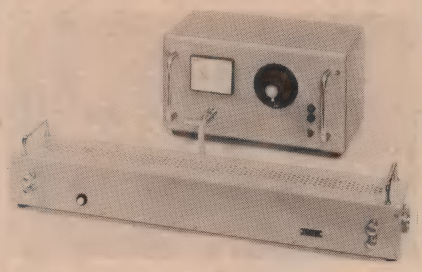
(continued)

NEW PRODUCTS

(*continued from page 49*)

sils. Designed for wall cabinets of the reach-in or reach-through type, the doors glide smoothly and quietly on low-friction rollers. They are sanitary, easy to clean and chemical-resistant.—Amerace Corp.

Circle 132 on Reader Service Card



GAS LASER

Model LG64 gas laser is an improved design capable of delivering 4 milliwatts of power in a single mode operation. Mirrors are fixed, but interchangeable for multi or single mode operation. Additional mirrors for other wavelengths are also available and focusing is accomplished by moving the entire discharge tube with micrometer screw gauges. Discharge tube life is guaranteed at 1,000 hours. — Siemens America Inc.

Circle 133 on Reader Service Card

GAS MANOMETER

Type H 51 manometer is a differential transformer transducer for operation from a 1,000-cps sinusoidal a-c source. Six models available cover the range of ±2 mbar (or 0 to 4 mbar) to ±10 mbar (or 0 to 20 mbar). With applications in nuclear physics, the gas manometer measuring diaphragms do not deflect more than 30 microns and corresponding volume variation is always less than 20 mm^3. Influence of external accelerations is eliminated by use of two transmitters in a single housing. — Société d'Instrumentation Schlumberger.

Circle 126 on Reader Service Card

8-MEV ACCELERATOR

This Van de Graaff accelerator, designated Model T 8/50, is capable of providing high-current performance at energies up to 8 Mev. It was designed for university nuclear physics research and teaching programs. The T 8/50 is a two-stage tandem machine which can be converted to single-stage operation. In

tandem mode, proton energies vary between 2 and 8 Mev. Guaranteed proton current rating is 50 microamps at 8 Mev, and over-all design aim of the machine is 200 microamps of proton current at 8 Mev. —High Voltage Engineering Corp.
Circle 124 on Reader Service Card

ULTRASONIC DISINTEGRATOR

This ultrasonic disintegrator indicates directly in watts, with power emitted from the probe tip. This permits excellent repeatability accuracy. Other features include a built-in timer, automatic tuning and 50% more intensity than previous models for processing large quantities of difficult cells such as yeast and staph, or producing fine emulsions or suspensions on a continuous basis.—Heat Systems Co.
Circle 140 on Reader Service Card

SILYLATING REAGENT

Trimethylsilyl acetamide, or BSA, is a highly reactive trimethylsilyl (TMS) donor that is calculated to be 50 times more powerful than other monosilyl amides that have been investigated. Conversion of high-melting organic compounds to thermally stable and volatile TMS derivatives is often quantitative under mild conditions. This provides a practical route for GLC determinations of usually intractable compounds such as carbohydrates, amino acids, peptides, steroids and others.—Pierce Chemical Co.
Circle 134 on Reader Service Card
(continued)

(Continued from page 51)

RECORDING HEAD

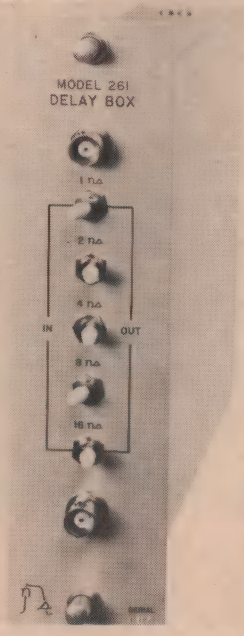
This flux-responsive, magnetic recording head is capable of resolving up to 20,000 bits/in. Called a bridge-type magnetic modulator head the device, which operates on the principle of flux-gating or magnetic modulation, can read while stationary and is sensitive enough to resolve displacement increments as small as 50 microinches. The basic head package consists of a glass-bonded ferrite pole-piece with a 60 microinch gap mounted in a ceramic or non-magnetic ferrite case.—Ferroxcube Corp.

Circle 131 on Reader Service Card

SUPERCONDUCTING MAGNETS

With field strengths ranging from 60 to 125 kgauss, this line of superconducting magnets is intended for research use in such fields as high energy physics, plasma phenomena, medicine and biology. The seven magnets, which use VAPODEP niobium-tin superconducting ribbon, have base prices starting at $8,550. Magnet bores are 1-in., 1⅛-in., 2-in. and 3-in.—Radio Corporation of America.

Circle 125 on Reader Service Card



CONVERTER

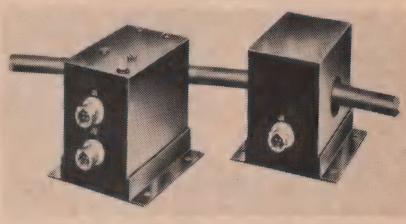
Model 290 Time-to-Amplitude Converter is intended to produce an output pulse whose amplitude is proportioned to the time separation between a start and stop input timing pulse. It may be operated in gated or ungated mode, depending upon the experiment. It will accept fast timing pulses from a variety of sources and present a suitable shaped output pulse to drive a multichannel pulse-height analyzer.—Nanosecond Systems Inc.

Circle 167 on Reader Service Card

REFRIGERATION CHAMBER

Designated the Versa-Range, this cascade refrigeration chamber has a temperature range from —100 F to +200 F. It has top loading to permit testing with minimum wasted time and effort. Working chamber dimensions are 18-in. wide by 16-in. high by 16-in. deep, yet the unit measures 43-in. wide by 68-in. high by 40-in. deep overall. It features the Power-O-Matic 60 saturable reactor proportioning control. —Blue M Engineering Co.

Circle 164 on Reader Service Card



CURRENT SENSOR

Designed for measuring large currents, the CRS 7-65 series current sensor produces an output d-c voltage proportional to the d-c current in a cable without interrupting cable integrity. Output is electrical-

ly isolated from input. Signal potential is limited only by the cable insulation which allows current sensing of potentials of 50,000 volts or more. High frequency response is available and all silicon solid state construction is featured.—Pioneer Magnetics Inc.

Circle 162 on Reader Service Card

VACUUM SEALS

This line of reusable metallic seals for high-pressure and vacuum applications incorporates features to prevent over-compression and assure equal stress distribution. Known as the Omega Seal, it includes basic materials of K-monel, stainless steel, inconel and aluminum and has a selection of coatings of teflon, silver, gold, nickel and lead. Zero leakage is assured up to 50,000 psi and temperatures of —420 F to +2,200 F.—Servotronics Inc.

Circle 161 on Reader Service Card

CARD EDGE/TAPE PUNCH

The LP-2 Perforator is available as a combination card edge/tape punch. Cards are handled in fan fold stacks and eight-level data is punched asynchronously at 150 characters/sec. No adjustments or equipment modifications are required for handling cards or 1,000-ft rolls of standard paper or mylar tape. In console form the units contain all necessary control and logic circuitry and power supplies. — Soroban Engineering Inc.

Circle 166 on Reader Service Card

MATTER OF OPINION

(continued from page 37)

other areas of biomedical knowledge involving complex systems at a high level of integration, will remain undeveloped until as much scientific attention is devoted to them as to scientifically better defined systems that are more fashionable. Certain groups of disease such as hypertension, obesity, peptic ulcer, bronchial asthma, or drug addiction illustrate the need for a new kind of approach to biomedicine, because they certainly involve long-developing disturbances in the chemical, physiological, and mental processes of the patient.

The biomedical fields that are presently neglected cannot develop through the mere extension of the knowledge acquired in the fashionable fields of science. A bold new departure is needed to provide a basis for the scientific study of organismic, environmental and biosocial problems.

One can anticipate that few, if any, universities or research institutes will find it possible to finance, administer, and maintain the large and complex facilities needed for effective research in these areas. It is not that the funds required would in today's terms be so large ($5 million might be the cost of one of these centers). It is rather that a facility in which one could study sizable populations of large mammals (say, 1,000 dogs) over several successive generations would entail a commitment of physical space and long term support not easily made within the framework of research programs at universities or institutes. It might be worth investigating, therefore, the possibility of establishing collective research facilities, perhaps on a regional basis. Advantage could be taken of the experience gained from the operations of research centers of the Brookhaven National Laboratory type to establish similar laboratories. Such biological research centers might remain integral parts of the university systems, even though operating as collective enterprises.

LITERATURE AVAILABLE

To obtain any of the following items, circle the number on the Reader Service Card that appears under the items of interest

Computers. Besides the total counter, which offers white and red cell counts, both the hematocrit computer and the MCV are available. Coulter Electronics Inc.*
Circle 15 on Reader Service Card

Signal correlator. The Model 100 computes the auto- or cross-correlation function of input signals and makes them available for continuous display. Princeton Applied Research Corp.*
Circle 9 on Reader Service Card

Stirred reactor. The Series 4500 features one and two liter capacities and corrosion-resistant construction. Parr Instrument Co.*
Circle 38 on Reader Service Card

High voltage supply. Rated for 10 milliamperes current, the 240A recovers from no-load to full-load within 35 millisec and supplies low noise voltages in 1-volt steps from 0 to 1,200 volts. Keithley Instruments*
Circle 28 on Reader Service Card

Pumps. The Blue Line diffusion pump and the Quick-Start ion pump are among the many pumps available, offering solutions to vacuum pumping problems. Consolidated Vacuum Corp.*
Circle 10 on Reader Service Card

Laboratory buyer's guide. This free catalog features flow measurement and control equipment and related equipment for metering and controlling liquid and gas flows. Brooks Instrument Div.*
Circle 29 on Reader Service Card

Particle accelerator. The T8/50, for use in expanding university physics research and teaching programs, is designed for tandem and single-stage operation in neutron and charged-particle work. High Voltage Engineering Corp.*
Circle 8 on Reader Service Card

Electrometer. The compact 401 detects currents less than 10^{-17} ampere, charges as small as 5×10^{-16} coulomb and resistances up to 10^{16} ohms. Cary Instruments*
Circle 4 on Reader Service Card

Pulse-stretcher and converter. For measuring nanosecond pulse amplitudes, the Model 124 dual gated pulse-stretcher provides the necessary amplification and pulse shaping to satisfy the requirements of a standard multi-channel analyzer. For high speed, the Model 143A analog-to-digital converter is available. LeCroy Research Systems Corp.*
Circle 17 on Reader Service Card

Instrumentation recorder. The SP-300 enables the expansion or contraction of the time an experiment lasts by recording the electric output of the measuring devices at 15 in./sec and playing them into the graphic recorder at 1⅞ in./sec. Ampex*
Circle 40 on Reader Service Card

Analog computer. Expansion to 186 amplifiers, solid-state FET choppers and four 0.01% amplifiers in a single module are a few of the features of the 505. Hitachi Ltd.*
Circle 25 on Reader Service Card

Ultrasonic cleaner. With a full 10 gal tank capacity and a 520 watt generator, the DiSONtegrator System 520 features broad band modulation and reflex-controlled autotuning. Ultrasonic Industries*
Circle 41 on Reader Service Card

Stop watch parts. Independent hammer springs and coil springs are two of the many features offered in the more than 50 models available. M. Ducommun Co.*
Circle 30 on Reader Service Card

Spectrophotometer. The DB-G is a double-beam, direct reading grating instrument, featuring common optics for sample and reference and the ability to convert to ratio-recording. Beckman Instruments Inc.*
Circle 5 on Reader Service Card

Lab equipment. Quality control aids, a variety of components such as lenses, prisms and wedges and an assortment of instruments are offered in this 1967 catalog. Edmund Scientific Co.*
Circle 39 on Reader Service Card

Electrometer. The Picometer offers stability from start-up through continuous operation and immunity to shocks. The Victoreen Instrument Co.*
Circle Back Cover Reader Service Card

Voltage source. Model X-336 standard voltage source is covered in this technical data sheet. Design features and specifications are given. 2 pp., Power Designs Inc.
Circle 174 on Reader Service Card

Phase microscope. The Phasestar's resolution and flatness of field enable the viewing of transparent and slightly pigmented preparations. A dual-viewing body accessory for simultaneous observation and choice of contrasts are also featured. American Optical Co.*
Circle 6 on Reader Service Card

Books. A wide variety of books for the researcher include those covering solid state physics, medical research, biochemistry and nuclear and high-energy physics. Academic Press*
Circle 20 on Reader Service Card

Temperature/humidity cabinets. Features of these cabinets include automatic electronic water levelers, heavy-duty non-cycling mechanical refrigeration systems and vapor pressure systems. Blue M Engineering Co.*
Circle 37 on Reader Service Card

Electronic equipment. A full line of electronic apparatus, including accelerometers, blowers, motors, gyros, potentiometers and many other items are listed in this catalog. American Relays.
Circle 168 on Reader Service Card

Oscilloscope methods. "101 Ways to Use Your Oscilloscope" is the title of this working handbook covering wideband scopes and the triggered sweep oscilloscopes. Howard W. Sams & Co. Inc.
Circle 169 on Reader Service Card

Dialyzer. A continuous countercurrent dialyzer for many applications is covered in this data sheet. Operation and capacity, dialysis rate and prices are among information supplied. 1 pp.; Omnivector Instruments.
Circle 170 on Reader Service Card

Computing amplifiers. This applications manual details computing amplifiers for modelling, measuring, manipulating and other uses. A library of practical feedback circuits is included. 116 pp.; Philbrick Researches Inc.
Circle 171 on Reader Service Card

(continued)

*From advertisement, this issue

LITERATURE AVAILABLE

(continued from page 55)

Gas chromatography. Preparative gas chromatographs PrepMaster and PrepMaster Jr. are described in this bulletin. Application information and hardware descriptions are given. 12 pp.; Hewlett-Packard.
Circle 172 on Reader Service Card

Ultraviolet analyzer. This data sheet describes Model 1056A automatic ultraviolet analyzer, giving adjustable wavelength and slit width and linear and logarithmic scales. 2 pp.; Technical Measurement Corp.
Circle 173 on Reader Service Card

Metallographic equipment. Folder describes and illustrates a complete range of apparatus for preparation of metallurgical samples based on the Knuth system. 4 pp.; William J. Hacker & Co. Inc.
Circle 141 on Reader Service Card

Microcircuit logic. Called the 13-Series Microcircuit Unicards, this line of microcircuit logic modules is detailed in short form catalog. 8 pp.; Canoga Electronics Corp.
Circle 142 on Reader Service Card

Syringe pumps. Series 255 syringe pumps, designed to deliver any flow rate required, are covered in this catalog. Specifications and applications data are given. 6 pp.; Sage Instruments Inc.
Circle 143 on Reader Service Card

Liquid nitrogen. The physical properties of liquid nitrogen and the design factors to be considered for its delivery, on-site storage and distribution are discussed in this brochure. 20 pp.; Union Carbide Corp.
Circle 144 on Reader Service Card

Photo-resist spinners. Detailed information and prices on the EC100 line of photo-resist spinners and the AHT series. Illustrations, applications and specifications are given. 16 pp.; Headway Research Inc.
Circle 145 on Reader Service Card

Data reduction. Instrumentation and methods for on-line reduction of random data are described in a set of data sheets. Signal averaging, auto- and crosscorrelation are discussed. 35 pp.; Technical Measurement Corp.
Circle 146 on Reader Service Card

Radioactive materials. Prices and details of eleven isotopes are given in this radioactive materials catalog. 25 pp.; Nuclear Science & Engineering Corp.
Circle 147 on Reader Service Card

Time indicators. This bulletin describes the 19200, 19600 and 19700 series of microminiaturized elapsed time indicators for operation on 400 Hz, 60 Hz and 28 volt d-c respectively. 2 pp.; The A. W. Haydon Co.
Circle 148 on Reader Service Card

Permanent magnets. The Lodex line of permanent magnets for applications requiring intricate shapes and close physical and magnetic tolerances is covered in this publication. 4 pp.; General Electric Co.
Circle 149 on Reader Service Card

Operational amplifiers. Two papers on operational amplifiers are entitled "An Introductory Laboratory Manual of Operational Amplifier Experiment" and "Operational Amplifier Quiz." 18 pp.; Nexus Research Laboratory Inc.
Circle 150 on Reader Service Card

Automated washing. This report covers automated laboratory glassware washing and drying. Equipment, techniques and specifications are given. 8 pp.; The Chemical Rubber Co.
Circle 151 on Reader Service Card

Excited gas technology. Applications bulletin describes excited gas technology, the elimination of filter matrices for analysis of submicron particles. 2 pp.; Tracerlab.
Circle 152 on Reader Service Card

Sewage testing. Brochure lists equipment and supplies for sewage testing laboratories, including reagents and other chemicals. Matheson Scientific.
Circle 153 on Reader Service Card

Field effect transistors. The Transistor Characteristics Tabulation publication features field effect transistors in the 21st edition. D.A.T.A. Inc.
Circle 154 on Reader Service Card

Aliphatic chemicals. This catalog includes pure aliphatic chemicals as analytical standards as well as laboratory services. Gas chromatography, lower fatty acid assays and other analyses are listed. 34 pp., Lachat Chemicals Inc.
Circle 159 on Reader Service Card

Index for Advertisers and Advertising Agencies

CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

THE NEW 1967 POLYSONIC MODEL DISONTEGRATOR® SYSTEM 520 ULTRASONIC CLEANER

only $999.95 (Export Model — 220V, 50 cycles $50.00 extra)

FULL 10 GAL. TANK CAPACITY
POWERFUL 520 WATT GENERATOR

America's most popular ultrasonic cleaner!
More sold than the next 3 makes combined!

OVER 30,000 INSTALLED

SAVES TIME • SAVES MONEY • THOROUGHLY TESTED • OPERATES COMPLETELY UNATTENDED • CLEANS WITHIN MINUTES • COMPACT • SIMPLE TO OPERATE.

Disintegrates injurious soils in seconds!

Why is it that most universities, research facilities, hospitals, atomic energy plants, military contractors, government agencies, municipalities, utilities and large companies buy only diSONtegrators? Because the equipment is superior — years ahead of competitive brands.

1 YEAR SERVICE POLICY

This new fabulous ultrasonic cleaning machine incorporates the latest advances in ultrasonic technology. Features broad band frequency modulation; reflex controlled autotuning. It's polysonic!

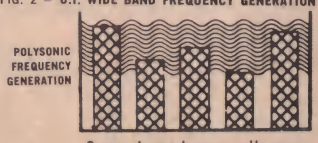
Meets FCC Specifications for Radio Interference

WHAT IS POLYSONIC?

FIG. 1 THE ORDINARY ULTRASONIC CIRCUIT

Typical transducer frequency deviation pattern excites only those transducers in the single narrow band frequency level. Wasted power. Overloaded transducers.

FIG. 2 – U.I. WIDE BAND FREQUENCY GENERATION



Same transducers all energized by polysonic frequencies. Balanced drive, no overloading, no lost power, high reliability.

OVERLOADED UNDERLOADED UNIFORMLY DRIVEN

Patent Protected

SPECIFICATIONS AND PRICES

GENERATOR		**Model G-520C1P**	**Model G-520C2P**
Input:		110-117V-50/60 Cycles, 12 amp	220-240V-50/60 Cycles 6 amp
Output:		80 ± 8 KC-520 watts average	2080 watts peak
Dimensions:		18" L x 15" W x 10" H (C)	

TANK Model No.	**Capacity**	**Inside Dimensions (length x width x depth)**	**Prices**
T-520C1	10 gals.	20" x 11½" x 10" (c)	$399.95
T-520C2	12 gals.	20" x 11½" x 12" (s)	$599.95
T-520C3	12 gals.	15" x 15" x 12" (s)	$599.95
T-520C4	12 gals.	48" x 5" x 12" (s)	$599.95

COMBINATIONS

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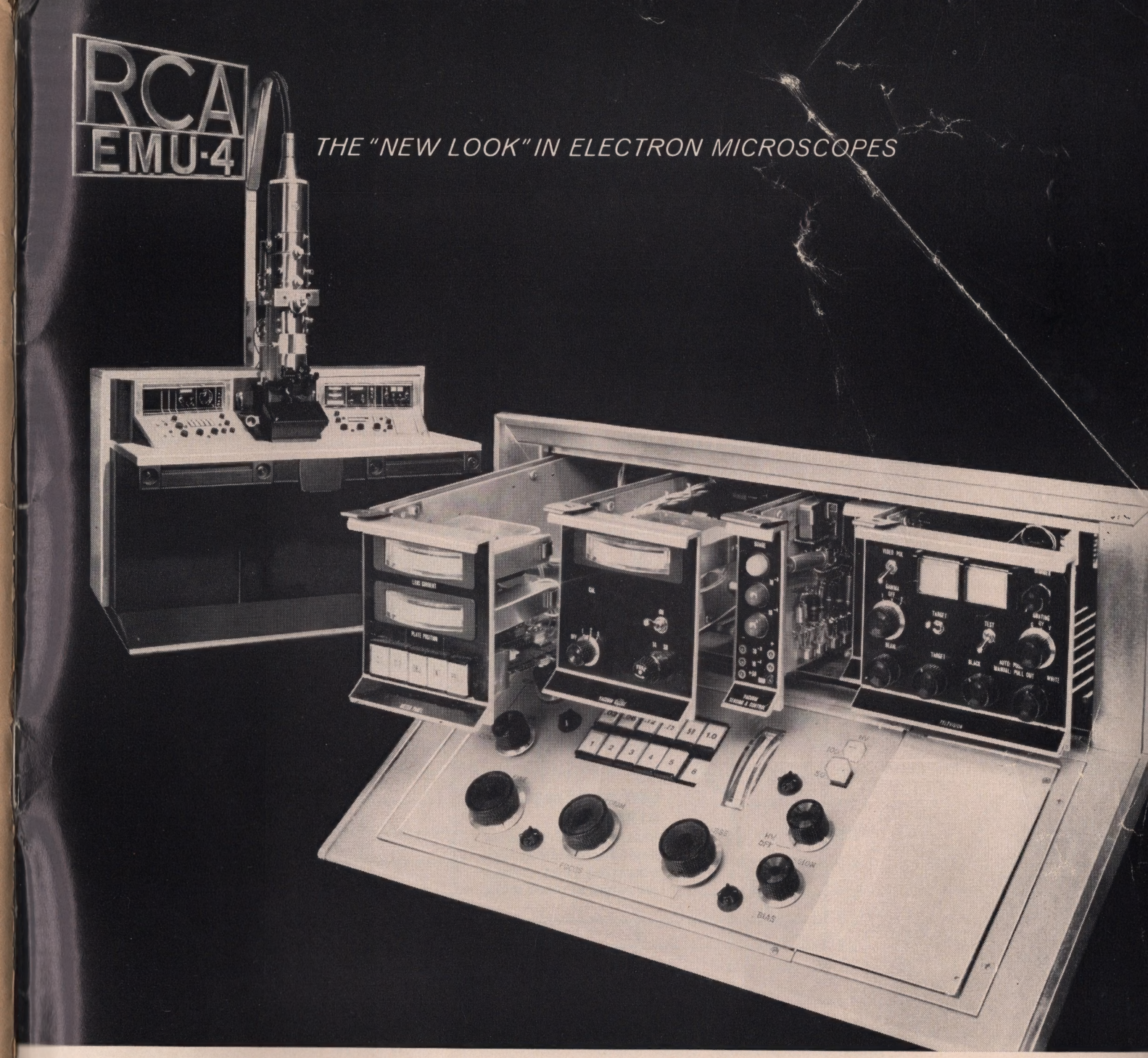

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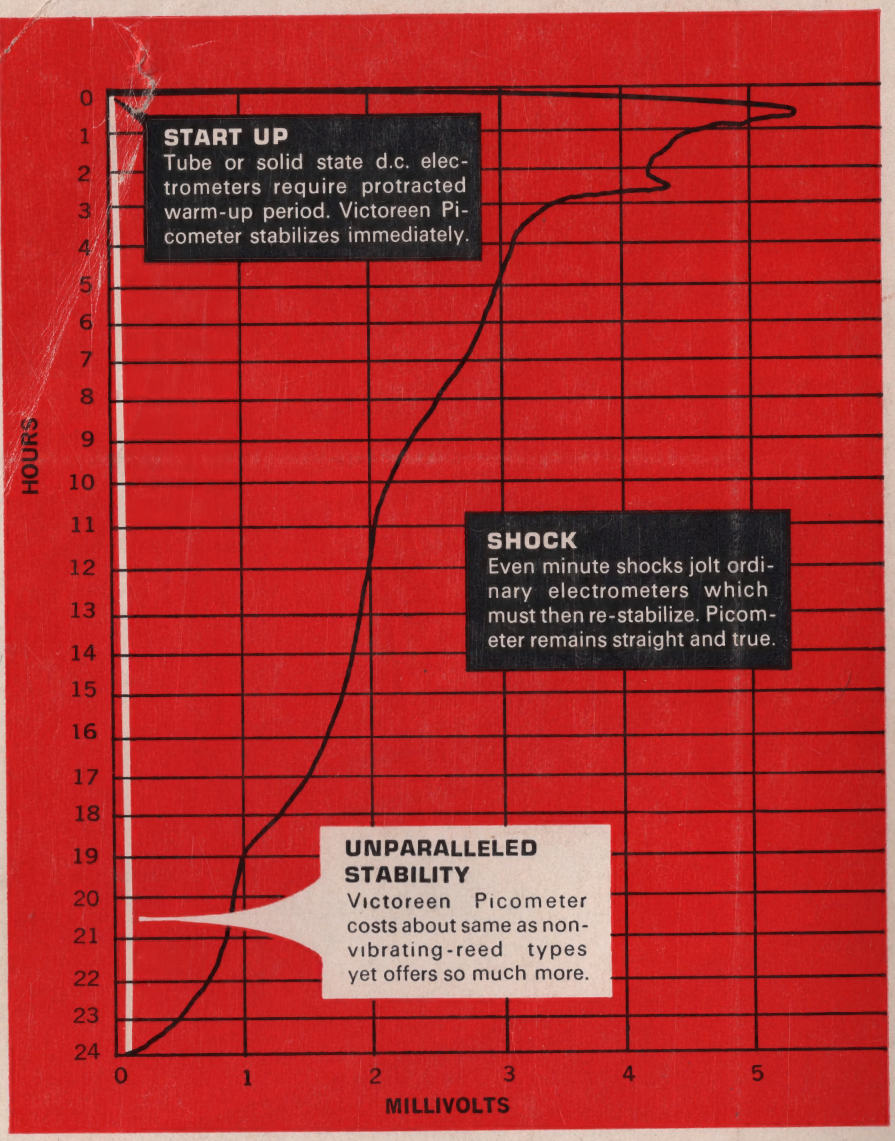

Comparative curves prepared from a strip-chart recording, with curves made simultaneously under identical conditions on 10 mv range. Note Picometer, compared to other best-known make of electrometer, is stable from start-up through continuous operation, is immune to shocks. Picometer voltage measurement 10 mv — 30 V, current 3×10^{-14} — 10^{-7} amps, input impedance 10^{15} ohms minimum. 7041-A

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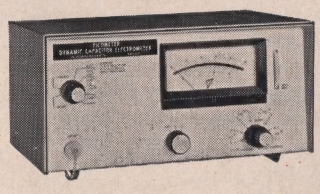

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